Dr. Mann's Report on Engineering Education

Engineering News-Record

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ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN, Editor — CHARLES WHITING BAKER, Consulting Editor

Volume 81 — NEW YORK, THURSDAY, OCTOBER 24, 1918 — Number 17

Full Energy in War Work

BUILDING the River Rouge submarine chaser plant in two months, as told on p. 755, was a typical war-time achievement. All hands worked faster than ever before, with a result almost miraculous as compared with normal construction performance. Such drive is a manifestation of the spirit that on the battlefield makes the army resistless. And the successful accomplishment has the same value as a victorious battle; beyond its immediate fruits, it bears an inspiration of power and success for the next task to be encountered.

Raising Sunken Ships Not a Simple Matter

THE mystery of the sinking of the steamer "St. Paul" at her dock last spring is in no way solved by the detailed description of her raising that this journal is now permitted to publish on p. 764. In ordinary times ocean liners of long-established safe design do not capsize in calm rivers under normal loads, but these are not ordinary times, nor does a possibly wise censor permit any information as to abnormal loading or on rumored changes in the vessel's design which may have affected her stability. It appears that the real causes of this accident and of the similar, though still more inexplicable, sinking of the "America" last week in New York Harbor must wait until after the war. The available facts of the raising, however, testify to the magnitude of the operations involved. Lifting this enormous mud-filled and opened hull first to an even keel and then to buoyancy from its resting place in 40 ft. of water in a congested slip required an ingenuity of supervision and a skill of individual execution far beyond the ordinary. The difficulties of the job do not promise well for the fantastic schemes proposed to reclaim the many equally large victims of the submarine from the ocean bottom around Great Britain and in the Mediterranean.

Provide Repair Materials for Accidents in War Time

AMONG hazards of war comes inability to secure materials for emergency reconstruction necessitated by accident. Destruction by flood and reconstruction of the irrigation aqueduct described on p. 761 exemplify this hazard. Twelve thousand acres of grain, alfalfa, sugar beets and minor crops in this instance depended for rescue solely upon the speed of reconstruction of the aqueduct. There were a score of things, including scarcity of labor, to handicap speed, but above all other obstacles towered scarcity of vital materials. Because wire rope had been commandeered by the Government for the supreme purpose of war, makeshift suspension cables had to be pieced together of such rope as could be obtained from dealers in second-hand materials. To this fact indirectly was due the second collapse of the aqueduct, which further postponed for 16 days restoration of water to the thirsty land. Presumably, in a case of this character, where vital war interests depend upon speedy restoration, priority will be granted for obtaining the materials needed, but the process is a slow one, and ordinarily the constructor must depend upon his own resourcefulness in finding what he needs if he expects to rescue his endangered property. Precautions cannot easily be specified, but now is a time when works managers can least afford to risk accidents to producing plant or equipment.

Unharnessed Water-Power Expensive and Dangerous

INTERFERENCE with the régime of a river is likely to have disastrous results unless undertaken with the utmost caution and with a knowledge of all of the facts and conditions. After straightening a channel one must expect increased velocities, which will pile up water in the lower reaches and cause flooding of additional areas of bottom lands, and which may have sufficient power to cause serious erosion or destruction. Failure to recognize these conditions has resulted in costly troubles at Oklahoma City, as detailed on page 752. Drainage commissioners in the county straightened a channel above the city limits. To carry off the added volume through the city the latter permitted a cutoff to be made across a loop. Unfortunately, the city waterworks plant was located on the loop and was left without supply when the diversion works were washed away and the cutoff channel scoured to such depth as to take the dry weather flow. To date about $100,000 has been expended on lawsuits and in the numerous attempts to build a permanent spillway in the diverting or cutoff channel in order to maintain a flow at the water-works station. Most of this expenditure might have been avoided had the work been preceded by study of the hydraulic project as a whole. As many drainage reclamation projects will soon receive serious attention in a hurried attempt to provide after-the-war work, it is none too early to warn well-intentioned promoters of the necessity of engineering investigation and advice to guard against such possibilities as the destructive power induced by tampering with the régime of a stream.

After-the-War Road Work in Illinois

AS THE state-wide campaign for the $60,000,000 good roads bond issue in Illinois draws to a close before the election on Nov. 5, it is highly important that the project be actively and enthusiastically supported. The project is sound from the financial, economical and engineering standpoints.

Serial 20-year 4% bonds, to be retired by the automobile license fees, with maintenance provided for, is the financial scheme. The license fees, which already have practically doubled, will be collected anyway, and would build the same mileage or more in the 20-year period. In the piecemeal, patchwork plan a continuation of the present isolated section scheme would be inevitable. By the proposed plan the credit of the state would be used, bonds issued and sold as construction proceeds, and the 4800 miles built within a five-year period. Since no bonds are to be issued until peace comes the project answers the requirements of after-the-war work most admirably.

From the engineering standpoint the routes as laid out (see map, p. 777) will give Illinois in intercity system. It will connect with four national highways and serve nearly every county seat on the route and every town of 2000. Sixty-five per cent. of the people live on the roads in towns touched by the system, and 85 per cent. live within five miles of the road on 65 per cent. of the area of the state. The rational system of choosing routes and types of surface, according to traffic, population and property valuation, whereby the obvious engineering method of equal unit costs per user is a desideratum, was used in making the plans and estimates. In fact, the late W. W. Marr, state highway engineer, developed this method for comprehensive county systems with the state problem in mind. (See *Engineering Record* of Apr. 22, 1916, p. 536.)

To engineers as a class, one scarcely needs to note the very obvious necessities and economics of improved highways. Hoover says half the perishable food products of the United States are now wasted because of the lack of *convenient* transporation, and a quarter of that waste would feed Europe. Without the roads that Caesar and Napoleon built and France maintained, Paris would have fallen and the Verdun warriors could never have held out. Army transport trains crossing the State of Illinois from the Mississippi River east are not uncommon sights in Illinois. Fourteen rural motor express lines already radiate from Chicago a maximum of 70 miles. A brand new economy argument, with definite engineering data on which to base assumptions, was provided in August by the gasoline consumption tests on various types of improved roads and with earth roads near Cleveland by five two-ton army trucks. In the earth-surface test the consumption, 0.173 gal. per mile, was twice that on hard-surfaced types. Assuming that an average traffic of 500 motor vehicles per day for 300 days in the year is developed by the system proposed in Illinois, the whole $60,000,000 would be saved in four years, if gasoline remains at 25c. per gallon. This takes no account of the added commercial values developed, labor, tires or upkeep saved. From every angle, the engineer cannot engage in promoting to the limit a more meritorious public enterprise. By a peculiar law in Illinois a failure to vote on this particular proposition is equivalent to a negative vote. Illinois engineers have indulged in their share of academic debate on the civic duty of the engineer. Nov. 5 will be a good day to put it to the test.

Ship Launchings in the Lead

NOTABLE progress in shipbuilding is revealed by the large excess of ship launchings over completions month after month. Deliveries are limited by the rate at which vessels can be fitted out with engines, boilers and equipment. Hull construction is no longer the neck of the bottle. Thus the first great task of the Emergency Fleet enterprise is well in hand.

Steel mills, fabricating shops and ship erectors have held their pace well in taking the lead of their fellow workers of the machinery department. When the great work of building a carrying fleet for the world was undertaken, shipyard capacity was small compared with engine- and boiler-shop capacity, but that handicap has been overcome and the ship erectors now are showing the way.

There must be no relaxation of shipbuilding effort, however. On the contrary, increased drive is needed in the hull department. Every ounce of energy must be put into the work. It is true we are setting new world's records in ship production, but the unprecedented September figures, noted on p. 733 of last week's issue, and the still higher figure expected of October, are empty distinctions if the world's urgent need for ships is not being filled. Launchings will be rapid enough only when we use every pound of available steel and every worker that can be enlisted. And the steel supply will not be large enough until it develops the maximum output of every shipbuilding berth.

To speed up the production of equipment and the work of installation is a separate task. As to production, the ultimate responsibility rests on the Emergency Fleet Corporation, which alone can coördinate and drive the shops and factories which it has put to the work. For accelerating the fitting-out operations, the yards themselves may be depended upon. Some are even now completing their ships within a month after launching. Others, which require three to four months for the same work, are not likely to stay behind very long. As the slow work comes up to the pace of the most rapid, it is certain that completions will crowd the fabricators and erectors, and that hull and machinery departments will enter upon a keen competition for speed.

Appreciation for the excellent launching figures is due both the shipyard men and the builders of the new yards that now are launching ships. Energy and efficiency have been in evidence in the yards since last fall, when the Emergency Fleet Corporation actively began its work. Old ideas of construction speed were the first to give way under the demands for fastest possible production. Thereafter, old ideas on shipbuilding schedules were made obsolete by new and undreamed-of speed in the fabricating shops and on the berths. The rate at which ships are now being launched is the product of more than mere growth in number of yards and number of ways. There is new working efficiency, new intensity of production in the shipyards.

The Significance of Dr. Mann's Report on Engineering Education

DR. MANN'S report on engineering education has been issued. The bright promise of his method of investigation has been borne out in the fruit. The document is epoch-making, provided the profession and the schools can rise to the responsibility which his analysis shows is placed upon them.

To the hasty reader the report may appear elusive. It does not lay down a hard and fast set of curricula. Rather it seems to pass the task to the schools.

The careful reader, however, will see in the report an inclusive and fundamental analysis of the essentials of engineering practice and of the purpose of engineering work. He will see in it a beacon not alone for the guidance of engineering education, but of the practicing profession. The document has come at a most opportune time—in this hour of searching analysis into the function, the status, the organization of the whole engineering profession. We trust that every engineer, no matter what his specialty or his rank, will read and digest the report, that he will freely express his views, and that the report will be the topic of at least one meeting of every engineering society in the land. We trust that it will be analyzed from every standpoint, that the disagreement and the approval will be equally frank, since in rallying the forces of engineering for great ends we must know what support will be accorded the new standard that will be advanced.

For ourselves, we subscribe heartily to the report. We do not assert that it is all new. In fact, no instrumentality, no individual or society or organ, has championed more strongly or expressed more clearly than *Engineering News-Record* and its constituent journals the broad responsibility of the engineer, the responsibility for the human as well as for the material factor in industry. Nowhere has the engineering foundation of our whole social and economic structure been so strongly emphasized. But most of us have talked about effects, about the objects to be attained, without perceiving the fundamentals, divested of all accidental and qualifying factors.

To strip off the unessential and to point to the unescapable conclusion from the fundamentals—that has been Dr. Mann's task, and he has performed it well.

For example, he crystallizes the whole purpose of engineering in the phrase, "to increase production." Therein we can find full justification for the advocacy of the handling by the engineer of all the human problems incident to industry—for the man is a factor in production. In turn, the industry reacts on the man. What he is, his wife and children, depend on his pay and treatment, the thoughts he brings back with him from the mill, and factory and mine. And in turn, the social structure is modified by what he thinks, by the thoughts—whether of satisfaction or discontent—he brings home from his daily work. Again, increase in production requires that the engineer inquire into the finances of industry, for finance is but the handmaiden of the productive process, and finance is going to be reconstructed along engineering lines.

Equally encouraging is Dr. Mann's definition of the professional engineer, "not as a conglomerate of classical scholarship and mechanical skill, but as a creator of machines and the interpreter of their human significance, well qualified to increase the material rewards of human labor and to organize industry for the more intelligent development of men."

The service Dr. Mann has rendered the schools in his report includes, of course, the statement of professional ideals and purpose, already commented upon. Of the more specific service he renders is his definition of the essentials of engineering practice—essentials long recognized by the practitioner but neglected, as to some elements, by the schools. He reduces the essential factors of engineering practice to three: Knowldge of engineering science, skill in technique of application, and judgment in the appraisement of values and costs—these three to be harmonized with respect to the fundamental elements in production, materials and men.

If this analysis be accepted as correct—and we look for no differences regarding it among practitioners, and but little difference in the schools—the kind of engineering education to be developed is not difficult to lay down in general terms. The difficulty comes in the machinery, in the content and mechanism of the courses which will impart the necessary theory, practical experience and judgment of values as to both the material and human elements of production.

Obviously, the application of Dr. Mann's ideas requires complete reorganization of the schools—reorganization of courses and of teaching personnel, and a change of the spirit of the institutions. But what a time for reorganization! The spirit is in the air. Ideas are unloosened. Prejudice has given way to openmindedness. We are more ready than in a generation to see and accept the truth.

Furthermore, the old curricula have been thrown aside. All schools are now army posts. The courses are even today undergoing a remodeling, and while the practical problems being woven into them are military rather than industrial, the fundamental plan is the same, and Dr. Mann, as a member of the educational committee of the War Department, sees that a good start is being made in the right direction. So, too, the objective-test system will soon replace the entrance examination for selecting the members of the Students' Army Training Corps. The transition will therefore be the easier when the war is over.

In sum, then, the Mann report has not only come at the right time to put a great task before the schools, but is opportune in its statement of engineering ideals and purposes. It displays a grasp that appeals to the intellect and a spirit of optimism with reference to the position of the engineer that calls strongly to those who have chafed in the narrow rut imposed by an apathetic profession and who understand the economic and social consequences of the industrial system which engineering has builded. And the word of encouragement is all the stronger in that it comes not from an engineer (albeit he is a scientist—a user of the scientific method), but from an outsider, one who looks on without prejudice and whose sole object has been to get all the facts.

His report is heartening. It is a guide to action in educational reconstruction and lays down the fundamentals which must be taken into consideration in professional reorganization.

Dr. Mann Reports on His Three-Year Study of Engineering Education

Proposes Not a Standard Curriculum but a Method by Which Engineering Colleges Can Construct Courses to Meet Present-Day Engineering Demands Which Are Fully Outlined in the Report

ENGINEERING education in its primary conception is a means by which production can be increased. This, the belief of Dr. Charles R. Mann, dominates the comprehensive report he has just made on engineering education. From that principle he argues that knowledge of the human factor in production is as important as that of materials; and his investigation indicates that engineering schools treat of materials extensively, but not of the human element. He also finds a need for much more instruction in the appraising of values and costs. What he proposes is not a standard curriculum, but a method by which engineering schools can construct courses to meet present-day demands, coupled with a more rational means of testing and grading the abilities of the students before admission and throughout the courses, thus directing them with greater certainty to the specialty for which they are best fitted.

What the Report Is

For more than three years Dr. Mann has been making his study of engineering education under the joint auspices of the Carnegie Foundation for the Advancement of Teaching and the Joint Committee on Engineering Education of the national engineering societies. In 1907, states the introduction to the report, the Society for the Promotion of Engineering Education invited the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Chemical Society to join it in the formation of a joint committee to examine into all branches of engineering education. The next year the Carnegie Foundation was invited to appoint delegates to the committee, and subsequently the Carnegie Foundation undertook to carry out the investigation on a large scale and bear the expense of it. Dr. Mann was retained to give his entire time to it. The committee has been closely associated with Dr. Mann during the work.

The following signers of the introduction constitute the committee: Desmond FitzGerald, chairman; Onward Bates and Daniel W. Mead, for the American Society of Civil Engineers; F. H. Clark and Fred J. Miller, for the American Society of Mechanical Engineers; C. F. Scott and Samuel Sheldon, secretary, for the American Institute of Electrical Engineers; Clifford Richardson and Henry P. Talbot, for the American Chemical Society; J. R. Withrow, for the American Institute of Chemical Engineers; Henry M. Howe and John Hays Hammond, for the American Institute of Mining Engineers, and D. C. Jackson, G. C. Anthony and C. R. Richards, for the Society for the Promotion of Engineering Education. Henry S. Pritchett is president of the Carnegie Foundation.

Dr. Mann's study has covered not only the character of present instruction, but also the type of men demanded by present conditions. He recommends a method rather than a standard curriculum, because he holds that no school will make a success of a course planned in the light which his report furnishes, unless its faculty is thoroughly in sympathy with the new point of view—so thoroughly that it is capable of working out courses aimed to accomplish the new end.

Of the ideas which Dr. Mann offers as necessary ingredients of a new method of training engineers, one of the most important is the adoption of testing and grading methods which will not only eliminate from admission to the schools those not qualified to pursue engineering studies, but will reveal throughout the course the progress of the student—progress not with reference to purely academic ideals, but to the equipment he will need in active professional life. Such objective testing and grading methods, he contends, will not only eliminate the unfit at the start, and insure progress having a relation to the needs of engineering practice, but will furnish a sound test of the abilities of teachers and spur them on to creative teaching work

Four "Common-Core" Essentials

The method Dr. Mann proposes for the actual formulation of the courses is to have in each school a standing committee which shall decide what he calls the "common core" of all engineering education, no matter what the specialty. This "core" being defined with reference to the needs of the engineer, the committee would determine the time necessary to cover it adequately and would shape the courses accordingly, instead of arbitrarily parceling off to the different departments the time predetermined as available and letting each department crowd as much as possible into its allotted time. The "common core" would have studies under four main heads: (1) Participation in real industrial work; (2) engineering laboratory work, including drawing and descriptive geometry; (3) mathematics and science and (4) humanistic studies. Participation in industrial work would best be interwoven with the three classroom and laboratory divisions of the student's work, and as an example of what can be accomplished in this line, Dr. Mann endorses emphatically the coöperative system of engineering education developed at the University of Cincinnati and since applied at other institutions.

At the beginning of the course and while giving the common-core studies, the testing and grading methods already referred to would be given.

In addition to the standing committee to take care of the "common-core" studies, there should be additional committees, one for each of the semi-specialties offered at the school, such as civil, electrical and chemical engineering. Here the same method would apply: that is, the committee, having a clear-cut conception of the demands of present-day engineering, would determine first the equipment needed by young graduates and

then the time required to obtain that equipment, and would develop the courses accordingly. This semi-specialized work would follow the "common core" studies, and again grading and testing methods would be used which would indicate the relationship between academic attainments and the qualities needed for success in engineering work, and would be a guide in choosing further specialization.

A clear conception of the spirit of Dr. Mann's study and of the line of reasoning which has led to his conclusions can best be obtained from the chapter of his report entitled "The Professional Engineer."

"Because the engineering schools have always made it their chief aim to impart the technical information needed in industrial production," says Dr. Mann in explaining the character of his investigation, "and because both scientific knowledge and industrial practice have grown so rapidly, the attention of technical schools has been focused chiefly on keeping up to date in science and practice. The university emphasis on research in natural science has also tended to magnify the importance of technique and to minimize the importance of personality. . . . Therefore it seemed necessary to consider the question whether this emphasis on technique is producing a new and higher type of engineer, or whether the engineering profession still stakes its faith on the fundamental thesis that personal character is, after all, the real foundation for achievement."

> THE general plan of the proposed reorganization of engineering education is based upon an analysis of engineering practice into its three essential factors—knowledge of engineering science, skill in technique of application, and judgment in the appraisement of values and costs. The overlapping claims of these essential factors must be harmonized with respect to the two fundamental elements of production—materials and men.

To arrive at the requirements of the engineering profession an extensive inquiry was made, outlines of which have been published in *Engineering News*, *Engineering Record* and elsewhere. Circular letters were sent to engineers throughout the country, asking them what they deemed the most important factors in determining probable success or failure in engineering. In the replies received personal qualities were mentioned seven times as frequently as knowledge of engineering science and the technique of practice. Of six groups of qualities headed respectively character, judgment, efficiency, understanding of men, knowledge and technique, the summarized votes of more than 7000 engineers placed character at the head of the list by a majority of 94.5%, and technique at the bottom by an equally decisive majority.

Thus it appears that even before our entry into the war—for the inquiry described was completed in 1916—there was keen appreciation of the importance of the personality of the engineer. Since then Dr. Mann thinks events have brought out that need even more clearly. The remainder of his chapter on "The Professional Engineer" is reprinted herewith substantially in full.

"Progress is being made toward the conception that there is really but one profession of engineering, in spite of its apparent division into the several well-known branches. War conditions have not only hastened public recognition of the engineer as an expert in applied science and fostered solidarity of the profession, they have also opened to him new fields of activity. Back in 1914 most people believed that the war could not last long because enough money could not be found to finance it. But three years of experience has made it clear to every one that although money is plentiful, it is useless if there is nothing to buy; so that winning the war depends on increasing production by an amount which has been estimated as the output of at least 10,000,000 additional industrial workers. This extra production may be secured either by training more workers or by increasing the output per worker by engineering methods. Hence there has arisen a pressing demand for men who can deal with labor and with business administration in the engineering spirit. This demand is further emphasized by the fact discovered by the Federal Trade Commission, that only 10% of the manufacturers in the United States know their actual costs of production. The determination of these costs requires a scientific study of production which only an engineer can make. This work involves the analysis and apportionment of overhead expenses, and thus leads at once to such fundamental questions of economic justice as: Should the capital invested in idle machinery be paid wages though idle workingmen are not?

"These new opportunities for the engineer have been gradually developing for a number of years, but the profession as a whole has been slow to discern them. The war has focused attention on them and precipitated a general recognition of them. It is also evident that the mastery of these new activities depends in greater measure than does mastery of the traditional types of engineering on the personality of the man. The success of a designer of bridges or of machinery is not necessarily impeded by lack of insight into human nature or of failure to comprehend the things that mankind considers most worth while. But to the man who would deal successfully with human labor and with business, personality is usually a greater asset than technical knowledge and skill. Therefore as engineering expands into the new fields now opening before it, the conception that character, judgment, efficiency, and understanding of men are no less necessary than technical knowledge and skill will become more and more impelling, and it will become more and more essential that schools of engineering pay greater attention to the effect of their work on the personal development of the students. . . .

"The ultimate aim of engineering education has

always been and still is more intelligent industrial production. Technical schools were founded when industrial evolution had progressed so far as to create a pressing demand for men who knew how to utilize the new and rapidly expanding knowledge of natural science to increase and improve production. Science was then little taught in high schools and colleges, so that both the public and the manufacturers were ignorant of it. Under these conditions the obvious need was for scientific enlightenment; and this the engineering schools were organized to supply. . . .

"The schools . . . have contributed enormously to the achievement of two striking results: namely, the extension of science instruction into the school system generally, and the development of public recognition of engineering as a profession, coördinate with theology, medicine and law. At the present day an encouraging fraction of the people are reasonably intelligent in science, the worker in applied science has become socially respectable, and there has been developed a large conception of the engineering profession. Meanwhile the methods of dealing with the material problems of industry in a scientific way have been in a measure established, while the more intricate problems of organizing and managing men are rapidly pressing forward and demanding engineering treatment.

"The net result is that the curricula and methods of instruction that were devised to supply the intellectual element in production by imparting knowledge of natural science must be reorganized to meet the new industrial demand for engineering administrators and the larger professional demand for men of strong personality. The general plan of the proposed reorganization is based upon an analysis of engineering practice into its three essential factors: namely, knowledge of engineering science, skill in technique of application, and judgment in the appraisement of values and costs. In every engineering project the overlapping claims of these three essential factors must be harmonized with respect to the two fundamental elements of production, namely, materials and men. Surely every engineer should have some conception of the present conditions and problems in at least the general aspects of all these essential factors and elements. If this be granted, it is easy for any school to discover where its curriculum is overloaded and where it is deficient.

"This analysis also indicates how the present organization of school work can be modified so as to furnish a more vital training for professional engineers. Thus, with regard to materials, the schools do give careful instruction in the laws of physical science and in the properties and uses of materials. Students are taught the relative strengths of substances in the materials laboratory, kinematics teaches the principles of gearing, the shapes of gear-teeth are worked out in the drawing room, the chemical properties are taught in chemistry, mechanics deals with the forces required to overcome inertia, machine work is relegated to the shop, and so on. But seldom is all this information coördinated in a single practical problem, such as determining whether mild steel, nickel steel or phosphor bronze is the best thing to use in making a particular gear wheel; nor is the student ever asked to judge what combination is likely to produce the most valuable result for the price. Yet this balancing of value and cost is the controlling factor in all intelligent production. Again, little consideration is given in courses in machine design to the comfort and safety of the operator. Yet a punch press, for example, that requires a workman to use both hands to operate it is far more intelligent than one that takes a large annual toll of fingers because the driver has one free hand. Similarly the importance of good heating, lighting, ventilation and sanitation in increasing the output of workers and in keeping them strong and healthy should always be taken into account. These human factors enter in large measure into the determination of the values secured for a given cost.

> THE first message of the profession to the schools is—Motivate your work by making it worth while; for character, judgment, efficiency and understanding of men develop best in men who work with enthusiasm and intelligence at things that they believe to be worth while.
>
> A second message—Training in ability to perceive relationships — interrelation — is one essential for the development of resourcefulness, common sense, perspective and efficiency.

"It thus appears that an adequate treatment of the first element in production involves not only a scientific presentation of the laws of nature and the properties of materials, but also an estimation of the values and costs from both the material and the human points of view. The chasm between the school and practical life is due largely to a failure to appreciate this fact. The introduction of the study of values and costs in all their phases is the most direct method by which the schools can bridge this chasm. Such study is also one of the most potent means of liberating creative energy and of developing the spirit of investigation.

"With regard to the second element of production—men—most schools at present are doing practically nothing to arouse the students to an intelligent appreciation of the problems of personal and human relations in production. Yet these problems are every day becoming more acute, as indicated by such movements as Americanization, human engineering, industrial engineering and scientific management, with their various efforts to improve the condition of the workman and to increase his output in production. Many of the burning questions of the time lie in this field. The loss to industry from turnover—the hiring and firing of workmen—is variously estimated at from $150,000,000 to $400,000,000 a year. This expense adds from 7 to 20% to the cost of production, and yet it injures rather than benefits the product. What are the means to prevent turnover—better housing? better social con-

ditions? higher wages? profit sharing? opportunity for self-expression? juster economic treatment? or more kindliness? Does the time-study method of speeding up work pay? Does it really relax or wear out the worker? Does it produce the best type of citizenship among the industrial classes? These and many other similar unanswered questions are now waiting for an engineering analysis, and the country looks to the engineering schools to train men who shall be able to answer them.

"The training of men for the solution of these human problems cannot be carried out in the schoolroom alone. The students must have some vital, first-hand, personal contact with labor and workmen's conditions, either by a coöperative system, as at the Universities of Cincinnati and of Pittsburgh, or through the industrial service movement, or in some other real and living way. Hence meeting this demand requires some form of closer coöperation between the engineering school and the industries, better understanding of their mutual relations, and willingness on both sides to approach the problem with the true research spirit. Such coöperation is needed not only to give the students a vital conception of the workman's point of view, but also to furnish that intimate personal knowledge of the details of production which cannot be secured in college laboratories and shops. The lack of this sense of the physical properties of materials is one of the chief reasons why less than five per cent. of the production managers in this country are college-trained men.

"It is, however, in the matter of estimating values and costs that this problem assumes its most far-reaching consequences. The following are some of the typical problems now pressing for solution in this field: What is the effect of good housing on the development of the men, the efficiency of production, and the size of the profits? What is the most effective incentive to maximum output—the bonus system? opportunity for coöperation in management? opportunity for creative work? or shorter hours? Does the assurance of justice and a square deal always tend to increase output and also to foster the growth of a social spirit and of patriotism? Does a plant pay better when profits and output are increased by efficiency methods which give workmen no chance for self-expression? or when the development of the workmen is made an aim as well?

"Every manager will estimate the values and costs of these various methods of treating workmen in accordance with his own philosophy of life. There is as yet no conclusive evidence to prove these cases one way or the other. The successful manager today is the one who estimates most accurately the human values involved. Therefore, one of the most important contributions that the school can make toward the education of the engineer is to guide him in developing an attitude toward life and a philosophy of living that will enable him to judge rightly as to the things humanity considers most worth while. This is the meaning of the professional demand for larger opportunities for cultural and literary studies. It cannot be met by merely requiring more work of the ordinary academic type in history, in economics and in languages; but rather by introducing the consideration of values and costs into the regular engineering instruction.

"Some attention has already been paid by the engineering schools to the problem of organizing men into effective working groups. At the Massachusetts Institute of Technology, Pennsylvania State College and several other schools special courses in engineering administration are now given regularly. These courses deal mainly with the various types of organization, the technique of different kinds of management, accountancy, banking methods and economic theory. All of this is, of course, essential to every engineering administrator. Industry sorely needs men thus trained; for the determination of costs is relatively easy so far as materials and labor are concerned, but the overhead, because it includes the cost of maintaining the organization, is a matter of great difficulty. Analysis by engineers shows that the largest wastes in production are in the overhead expenses, and result from faults in organization, such as idle machinery, inefficient maintenance, poor routing, lack of foresight in purchasing, delays from lack of instruction from the office, and so on. The study of overhead expenses has led to many searching questions of economics and industrial justice with which the student will have to deal after graduation, but to which the schools have not yet given serious attention.

"But it is gradually becoming evident that the ultimate success of any organization depends on its spirit; and this, in turn, is determined by the manner in which those in control coördinate and interrelate the intelligences and imaginations of men. Great organizers and leaders in industry are those who not only master the laws of nature, but who also shape and control their organization through their power of estimating accurately the value which each worker esteems most highly. The engineers instinctively recognize this fact and the educational implications of it when they declare that character, judgment, efficiency, and understanding of men are even more essential to the practicing engineer than is knowledge of the science and technique of engineering. The educational interpretation of this professional demand is not nearly so mysterious as many have tried to make it. For the schools have already discovered that students learn best when they are inspired by the conviction that the work is really worth while. One of the most effective ways of making work seem worth while is by constantly relating it to the consideration

> THE organization of curricula proposed embodies the modern conception of the professional engineer, not as a conglomerate of classical scholarship and mechanical skill, but as the creator of machines and the interpreter of their human significance, well qualified to increase the material rewards of human labor and to organize industry for the more intelligent development of men.

of the whole range of values involved and all the costs. *Every decision in daily life is an answer to the question whether the value is worth the cost.* The omission of this mainspring of all investigation and inquiry from school work is perhaps the chief reason for the chasm that separates the schools from life. Hence the first message of the profession to the schools is: Motivate your work by making it worth while; liberate the spirit of investigation by making the game worth the candle; for character, judgment, efficiency, and understanding of men develop best in men who work with enthusiasm and intelligence at things that they believe to be worth while.

"But there is a second message in the professional demand. For the spirit of investigation accomplishes valuable results only when the investigator is resourceful, accurate and efficient in mastering facts, and when he has judgment, common sense and a wide perspective. These qualities depend on the ability to put things in their proper places at the proper times, which ability depends in turn on the perception of intrinsic relationships. The most successful organizer and executive is the one who perceives relationships so clearly that he can build an organization which acts to liberate the creative energy of each in ways that prove most helpful. Hence training in ability to perceive relationships —interrelation—is one essential for the development of resourcefulness, judgment, common sense, perspective, efficiency and the rest. This is also one essential to the acquisition of knowledge. Therefore in so far as the school work develops the student's ability to perceive relationships, in so far do knowledge and the desired personal traits increase together.

"It thus appears that so far as the school work itself goes, the professional demand for upbuilding of character along with increase of knowledge suggests at least two promising lines of educational experiment; namely, motivation and interrelation. The lower schools have long ago recognized the possibilities of these fields of investigation. In fact, the educational progress of the past century has centered around these two conceptions. Many fruitful experiments and a large literature have gathered about the subject of motivation and the related topics of interest, formal discipline and transferable training. In like manner much has been accomplished toward interrelation through efforts that have been made to correlate various subjects, as indicated by the terms commercial-geography, business-arithmetic, household-science, domestic-economy, agricultural-chemistry, soil-physics and the like.

"The organization of curricula proposed is suggested as one practical method of harmonizing the conflicting demands of technical skill and liberal education. It coordinates the results of numerous individual experiments in a consistent program. It recognizes all the essential elements and factors of engineering as well as the educational requirements of motivation and interrelation. It is not a utopian dream, but a summation of the best that has been thought, said, and done in education during the past two centuries. Finally, it embodies the modern conception of the professional engineer, not as a conglomerate of classical scholarship and mechanical skill, but as the creator of machines and the interpreter of their human significance, well qualified to increase the material rewards of human labor and to organize industry for the more intelligent development of men."

Beginnings of Engineering Schools

In developing his thesis Dr. Mann begins with a review of the inception and growth of engineering schools, but it is not necessary to summarize that part of his report here. Turning to present conditions, he finds almost unanimous agreement among schools, parents and practicing engineers that at present the engineering curriculum, whatever its organization, is congested beyond endurance. It is obviously absurd to require from the student more hours of intense mental labor than would be permitted him by law in the simplest manual employment. Yet on all sides the pressure of topics and subjects that have become important because of the extraordinary growth of science and industry is constantly increasing. In 1870 a student might choose his specialty at the end of his second year; now he must decide in many cases in the middle of his first year. Formerly the choice lay among civil, mechanical and mining engineering; now the selection must be made from some 28 branches. No one school offers curricula in all of these specialties, but all are offered somewhere, and enough are given in every school to render the selection during the freshman year of his life's specialty a peculiarly difficult matter for the student.

High Mortality of Students

Counts made for two years at twenty schools have shown Dr. Mann that less than 40% of all freshmen of engineering schools complete the course in the allotted time. Nearly half of the elimination takes place in the freshman year and about one-quarter more in the second year. During these years almost all of the time is spent on English, mathematics, foreign languages, chemistry and physics, and little opportunity is afforded for contact with real engineering projects. Hence many engineering students are eliminated before they have a chance to show their ability at their chosen profession.

As to prevalent types of instruction, Dr. Mann finds that each subject is taught very much as a thing unto itself. In mathematics, for example, it is held that the student mind should not be distracted from the mathematical form by the engineering applications. In chemistry the student is not given such a project as: "Make baking powder and determine whether it is better and cheaper than any you can buy"; his problem is always in the form: "Determine the chemical composition of this powder." So with electricity, the student is asked to measure the efficiency of an electric motor rather than to decide which of three electric motors is the best for the price.

Discussing the problems of engineering education as he sees them, Dr. Mann points it out as evident that when 60 out of every 100 of those admitted fail to continue through the course, the present systems of admission, whether by examination or by certificate, are not satisfactory. Obviously, a fairly large number of students who ought not to try to become engineers are permitted to undertake studies for which they have little natural ability.

The determination of a candidate's fitness to enter college depends ultimately, Dr. Mann concedes, on tests of some sort; and, as tending to eliminate the fallacies and vagaries of individual personal judgment, and make grading more a measure of ability and less an expression of conformity to the conviction of an individual, Dr. Mann cites a series of experiments made by Prof. Edward L. Thorndike of Columbia University. Thirty-four students were asked, among other things, to read paragraphs and answer questions as to their meaning; to supply missing words in sentences; to solve mathematical problems; to draw graphs from given data; to match each of a series of pictures with one of a series of verbal statements, and to construct simple mechanical devices from their unassembled parts. Each test was constructed as a series of graded steps of increasing difficulty, the first being so easy that everyone was sure to accomplish it, and the last so difficult that only the ablest could master it. The questions as a rule could not be answered from memory, and were of a kind that had to be answered by a short, unambiguous statement. Independent scorers in the tests repeatedly gave practically identical ratings. The records of the 34 men tested have been followed for three years. Five of the seven who stood highest received general honors, while five of the seven lowest in the test failed in more than half of their work and left school.

> IT IS conceivable that before long, admission to college and achievement in college may be liberated from the bondage of personal equations as grading becomes less a matter of individual bias and more a valid record of actual accomplishment; then academic marks may become significant to employers.

Similar tests were made by Professor Thorndike at other schools, with results that prophesied academic achievements as accurately as the college ratings for one year prophesied those for the succeeding year.

Dr. Mann does not point to any tests yet worked out as a final solution of the college-entrance problem. He holds, however, that enough has been done to show that these principles of testing are worthy of further investigation, and that methods have been indicated that point to real progress. He feels that when the colleges are able to define their admission requirements in terms of abilities, as measured by objective tests, instead of in terms of subject matter covered, it may be possible to lift the incubus of ignorance that now oppresses the secondary schools, to supply the colleges with freshmen much better trained and sorted on the basis of ability, and to reduce the mortality of 60% to a more reasonable figure.

Practicing engineers and teachers of engineering are in substantial agreement, Dr. Mann finds, that specialization and subdivision of curricula have gone too far. There is too little time for persistent thinking, too little opportunity to realize the joy of achievement and too much inducement to join in the scramble for credits. For this condition he blames, in large measure, the dominance of the college of liberal arts in engineering schools. Emphasis is placed in the curriculum on pure science, pure mathematics and the humanities, in order to liberalize the engineering schools and keep them from becoming too materialistic. The difficulty is that when the various departments submit statements of topics which each department considers essential to the student, the hours required to cover them all would be double or triple the number available. The various claims are then reduced within reasonable limits by a process of cut and fit, and each department takes the time awarded to it and uses those hours in any way it likes. Respect for departmental autonomy then forbids any investigation or scrutiny by the faculty of the aims, methods or results of the work of any one department. The proper way to attack the problem, in Dr. Mann's estimation, is to determine the equipment in mathematics, physics and the like that is essential, and the best manner of coördinating the work of the different departments.

As coördination between departments is necessary with reference to the time schedule, so Dr. Mann finds it absolutely essential with respect to the content of courses. He lays emphasis on the need for more logical and coherent sequence of topics, and a better adaptation to modern scientific theories. He urges the use of practical problems, and commends in this connection Prof. R. H. Fernald's course in power plants at the University of Pennsylvania.

"While the topics of this course," says Dr. Mann, "follow one another in a logical sequence, they are chosen largely from engineering practice, and include much of the practical information every engineer must have when he goes to work. Many of the problems are actual cases that really occur in engineering, so that they appeal both to professional instinct and to the senses of values and costs—in fact, many of them are openly problems that deal with costs of operation and maintenance in working plants. Yet the course is not a mere mass of useful information; rather, useful information is the vehicle for conveying to the student a firm grasp of fundamental principles and engineering methods of attacking and analyzing problems, not only from the point of view of scientific theory, but also with due consideration to the limitations imposed by practice and by costs. . . .

"There has always been and still is a strong aversion on the part of colleges to placing emphasis on the material and financial aspect of the engineer's work. Yet it is a burning question whether the commercial bearings of each subject cannot be introduced into every course in such a way as to increase enormously its use and its vitality without in the least impairing its inherent scientific value. The enrichment of the content of courses by judicious appeal to practice and costs is a problem that offers rich opportunity for further experiment."

The two serious obstacles to coöperation in the content of courses, Dr. Mann finds, are reverence for department autonomy and the lack of generally intelligible and transferable details and methods of testing. The latter emphasizes again the need for a better system of testing and grading.

To this subject of testing and grading Dr. Mann gives much attention. "The reasons why grades under present conditions do not act as real incentives to good work are very similar to the reasons why payment of wages to workers on the basis of time spent at work fails to result in maximum output and even tends to scale down the efficiency of the skillful to that of the slothful." Students, like workmen, are inclined to "soldier," and work merely for passing marks. Their marks often depend as much on their ability to conform to the personal points of view of their instructors as on their real achievement in mastering materials.

Professor Thorndike's Objective Tests

For the purpose of making a beginning at removing some of the ambiguities of current examination practice, Professor Thorndike devised for seniors in electrical engineering a series of objective tests analogous to those used in his experiments with freshmen. Quoting Dr. Mann, "Each test is intended to measure a specific ability, such as arithmetical computation, geometric construction, paragraph reading, understanding of words, mechanical dexterity or comprehension of diagrams. Each of these is a single activity, although requiring a complicated coördination of psychological processes. Then the tasks are so selected that their accomplishment can be indicated with little or no use of words, so that ability to perform the task is not confused with powers of verbal expression; and the errors of personal judgment in deciding whether an answer is right or wrong are reduced to a minimum. Because of this independence of the personal equation the results obtained by these tests at different schools, or at the same school at different times, are comparable with one another. . . . Cramming for any one set test may be avoided, since after the successful type has been found it is a relatively simple matter to construct 10 or 20 alternate tests on the same pattern. Again, the successive tasks on each test are arranged in the order of difficulty, beginning with one that can be correctly met by almost all students of the degree of training in question, and progressing gradually to one that can be done by only a few of the most gifted. Such a test is a scale up which the student climbs to the extent of his ability in the particular type of activity under scrutiny; so that, when the test is well constructed, his relative rank is determined without ambiguity by the difficulty of the task he can successfully master, rather than by an estimate of how much credit must be given for a partially completed task."

Objective Tests for Army

Similar tests are being tried on a very extensive scale on the members of the new National Army by Majors Yerkes and Watson, psychologists, who have accepted commissions in the Army for this purpose. Industries, too, are beginning to look to these tests to guide them in the selection and placing of workmen, in the hope of reducing the labor turnover that is costing the country several hundred million dollars a year. Although the movement is still in its infancy, enough has been done, Dr. Mann thinks, to forecast what may be accomplished by further scientific work in this field. "In engineering it is conceivable that before long admission to college and achievement in college may be liberated from the bondage of personal equations as grading becomes less a matter of individual bias and more of valid records of actual accomplishment. Then college grades may be transferable among colleges; then academic marks may become significant to employers; then the results of educational experiments may be stated in convincing terms, and then students may come to respect their records and strive to beat them without artificial stimuli in the way of academic honors and credit bonuses."

Closing his chapter on testing and grading, Dr. Mann concludes that, "Under present conditions, when current testing and grading systems are more largely estimates of the amount of static information possessed than of dynamic abilities, it is evident that ratings of personal characteristics and dispositions are essential for vocational guidance. Whether this will be so or not, when grades have been made to express abilities, whether correlations will be found between various temperaments and various types of ability or not remains an open question for further study. In the meantime, there is no investigation that is likely to give larger returns in fruitful progress than the scientific investigation of testing and grading systems; for tests control teaching, and objective records of achievement are one of the most potent means of releasing creative energy in both student and faculty."

Shopwork

Shopwork forms the last of Dr. Mann's problems of engineering education. "In American technical schools," he says, "shopwork still occupies a rather anomalous position. Few teachers of the mechanic arts have been granted the title 'professor,' and the work itself is seldom recognized as being of 'university grade.' Yet no one denies that it is an essential element in the equipment of every engineer; and therefore it has been tolerated by engineering faculties and allowed to develop as best it could. As a result there is no agreement as to the purposes and methods of shopwork. Nearly every school has a shop philosophy and a well organized shop method of its own."

The purpose of shopwork Dr. Mann conceives to be an aid in bringing to the student a conception of what is meant by production and what are its fundamental problems. Numerous forms of shopwork, as conducted by the schools, are described by Dr. Mann, but he gives most attention to the coöperative plan in operation at the University of Cincinnati, inaugurated by Dean Herman Schneider.

The Cincinnati Coöperative Plan

The students at the University of Cincinnati are divided into two groups, one of which is assigned to work in industrial plants while the other goes to school. At the end of each biweekly period the two groups change places, so that the shops and the school are always fully manned. In the shops the students work as regular workmen for pay, but the nature of their work and the length of time each stays on any particular job are subject to approval by the university. The emphasis of the school work is on theory and principles, but these are related to the shopwork by "coördinators,"

who visit the students during each shop period and then meet the several groups during the university period in special coördination classes.

About 100 of the industries of Cincinnati and vicinity are now coöperating with the university. The companies represent every important phase of engineering, so that the university is able to arrange the work schedules in such a way that each student progresses regularly through every phase of his specialty, from the crude and rough work to the more difficult and responsible positions.

Financially, this coöperative plan is very economical both for the university and for the students. The university has access without expense to shops and shop equipment that are worth millions of dollars and are never allowed to deteriorate or become antiquated. The total cost to the university per student per year is about $130, compared with $250 to $600 at schools of equal grade. The money earned during shop periods makes possible an engineering education to many a boy who could not otherwise afford it.

In addition to the financial advantage, however, Dr. Mann points out many educational advantages. The work, he says, has three marked points of superiority over that done in college shops: (1) It is real commercial production that must succeed or fail on its merits; (2) the variety is much greater than is possible in any college shop, and (3) the student is thrown into personal touch with workmen, thus coming to know their point of view in a sympathetic way, and securing a conception of the human problems of industry and the appraisement of human values and costs that cannot be acquired so well in any other way.

Another educational advantage pointed out is the use of "work observation sheets." Because it is obviously impossible for an industrial plant to permit its workmen to spend time giving instructions to green college boys, each student when he begins a new job is given a work observation sheet containing from 50 to 200 questions concerning the details of the job, and directing him to sources of information where he can find the answers. He is required to be able to answer and discuss these questions during the coördination periods. Shopwork thus becomes a series of exercises in defining and solving problems.

"With such rich opportunities for education lying plentifully about in every industrial plant," says Dr. Mann, "it is a striking anomaly that the schools make so little use of them. . . . The neglect of the possibilities of shopwork is responsible in large measure for the professional criticism that the graduates cannot apply theory to practice, for the establishment by large corporations of apprentice schools where its engineering graduates may complete their training on the practical side, for the preference shown by many firms for shop-trained rather than college-trained men, and for the insignificant percentage of production managers who are college graduates."

Suggested Solutions

The concluding part of the report is entitled "Suggested Solutions." As previously stated, Dr. Mann does not propose a standard curriculum, but rather a method by which engineering schools can work out courses to meet present-day engineering demands. As to the curriculum, the suggested solutions can be summarized as follows:

1. The number of required credit hours per week should be less than 18—preferably 16. This is not to decrease the hours of work done by the students, but to enable them to do all of their work more thoroughly. It necessarily involves extensive changes in the content of the courses.

2. Not more than five subjects should be studied at a given time.

3. Orientation, contact with real engineering projects, and practical experiences are essential.

4. Interrelation between the concrete and the abstract is necessary throughout the entire course.

In addition to these four requirements, professional engineers agree as to the need for broad and sound training in engineering science rather than narrow specialization; for considerable attention to humanistic studies, and for some conception of business management and the most intelligent methods of organizing and controlling men.

To reorganize its curricula along these lines, the first step for any school is the appointment of a small standing committee composed of men interested in the problem of better teaching, and able and willing to give considerable time to the work. The committee must first study the relations of the school with the adjacent industries, and, having selected the type of coöperative industrial work best fitted to the environment, it may proceed to formulate a curriculum for the school work itself.

"Common-Core" Studies

If it is agreed that the chief function of school work is to give the greatest possible mastery of the essential principles of engineering science, then there is a common foundation on which all curricula must be built. The first step, therefore, in framing a course of study is to define this common basis of all engineering as clearly as possible; that is, to make a list of all the facts, principles and processes that are essential elements in the equipment of every engineer. This will constitute a "common core" made up of three distinct parts: (1) Science (mathematics, chemistry, physics and mechanics); (2) mechanic arts (drawing and shop) and (3) humanities (English and foreign languages).

The current organization of the "common core" recognizes no inherent or intrinsic relationship among these parts. The sciences are usually treated as sciences pure and simple, without regard to their function in engineering; in the mechanic arts the instruction shops are as a rule purposely separated from the construction shops; and the humanities generally strive consciously and vigorously to get away from engineering in order that the student may get at least a glimpse into the mysteries of language and of literature, and a touch of culture. Before a more effective "common core" can be constructed, it is necessary to adopt a classification of the subject matter that obviously expresses the intrinsic relationship of the several component parts to the needs of every engineer.

More intelligent production, as frequently pointed out, is the ultimate aim of engineering; and every production project requires the coördination and adjust-

ment of three factors—scientific theory, mechanical practice and cost. Success in engineering comes to him who most often judges soundly concerning the best adjustment of these three complex factors. Therefore, engineering education is likely to be more effective in proportion as it fosters the development of skill in determining the most expedient adjustments among theory and practice and cost. A curriculum that recognizes the intrinsic relationships involved is not difficult to construct, after the fundamental common elements of all engineering have been selected; until these elements have been chosen, it is impossible to give more than a general outline, or skeleton, on which any school may easily construct a program by filling in with subject matter appropriate to the environment and its educational aim.

Four Types of Work Needed

A curriculum that satisfies all of the requirements mentioned would include at least four types of work as follows:

1. Actual participation in real industrial work, either during summer vacations or, better, through continuous coöperation with industries. This industrial experience must be supervised by the school and used as a source of problems and projects for scientific analysis in the classroom.

2. Engineering laboratory work, including drawing and descriptive geometry. Here the student would make the measurements and carry out the operations needed to enable him to solve the problems and projects that originate either in his industrial work or in his class work.

3. Mathematics and science, developed systematically in logical order, to furnish the backbone of the course.

4. Humanistic studies. The professional criticisms of the schools indicate that this field offers the greatest opportunity for effective changes in current practice, because lack of good English, of business sense and of understanding of men are most frequently mentioned by practicing engineers as points of weakness in the graduates of the schools.

The difficulty in present school practice evidently lies in the exclusion from the technical work of all consideration of the question of human values and costs; and, conversely, the isolation of the humanistic studies from all technical interest. But experiments show that technical work is more impelling and is, therefore, more fully mastered when it includes the consideration of values and costs; while humanistic work becomes significant, and therefore educative, when it starts from and builds upon the professional interest.

> EVERY production project requires the coördination and adjustment of three factors—scientific theory, mechanical practice, and cost. Success in engineering comes to him who most often judges soundly concerning the best adjustment of these three complex factors.

After the essential topics have been selected, as much time as is required to teach them thoroughly should be taken for this purpose. Two years may be enough, but if this is found to be inadequate, more time should be assigned. The important thing is that the essential elements be first selected, and then that time enough to master them be given, instead of the current practice of assigning the time and then covering as much as possible within the set limit.

The first step toward successful specialization is intelligent sorting of the students, so that each is led as definitely as possible into that type of work for which he is best fitted temperamentally. This requires that while the students are working through the "common core" every effort be made to discover the particular abilities and specific bent of each, not only by means of ordinary examinations and academic grading but also through objective tests of graded ability, personality estimates by members of the faculty, consideration of boyhood interests, and observations of each student's reactions to the different portions of the "common core." The work in the latter offers an excellent chance for vocational guidance.

"Common Core" for Semi-Specialization

For each main branch of engineering a curriculum must be framed on the same plan as that used for the "common core." Thus, for a civil engineering group a competent committee must first select all the elements essential to all civil engineers but not already included in the "common core," and these essentially civil-engineering elements would be organized into a consistent curriculum composed of the same four types of work required for the "common core." As with that, so here, the amount of time needed to master the material selected as essential in each group has to be determined by experiment.

The number of the semi-specialized groups at any one school may well depend on the location and the capacity of the school. The great majority of institutions will unquestionably have one of each of the four major divisions—civil, mechanical, electrical and chemical engineering. Because of the establishment in mining districts of state schools of mines, a number of strong schools elsewhere no longer offer courses in mining engineering. While every technical college should offer the "common core," it is an open question how many of the semi-specialized groups each should attempt to supply. There is an urgent demand, however, that a number of these schools add to these semi-specialized groups one in production engineering or engineering administration. The seriousness of this need has been emphasized by war conditions, which have demonstrated how essential it is, if maximum production is to be obtained, to apply engineering methods to accounting, to the management of men and to the organization of business. Until recently most schools have specialized in design, but the opportunity for the college-trained engineer is now much larger in the field of production and administration than it is in the field of design.

Same Humanistic Work for All

Throughout the period of semi-specialization it is desirable to continue all of the four types of instruction comprised in the "common core," but the technical work

of the several groups may be very different. In the humanistic work, however, the subject matter presented may well be the same for all, thus developing among engineering students a unity of purpose and outlook. This will be a great asset in developing a professional consciousness among engineers, because it tends to establish engineering standards by which to interpret and attack the industrial and social problems of the day.

The systems of grading and personality analysis used during the early portion of the course should also be retained.

Specialization

When the student has completed the semi-specialized work, if he has shown particular ability in some specific line, opportunity should be afforded to pursue his specialty in elective courses of highly technical content. Since these courses are for specialists who have elected them after a long process of vocational selection, they should deal with the more abstract and general phases of each subject.

THE scientific study of industrial education ranks with industrial research as a bond of union between the engineering schools and the industries. On the fuller development of both teaching and research depends the realization of the ultimate aim of engineering education, namely, more intelligent production.

Seven Differences from Present Curricula

To summarize, the plan of curriculum proposed differs from curricula as at present constructed in seven important ways:

1. The subject matter essential to the equipment of the engineer determines the time schedule, instead of arbitrary time limits determining the amount of this subject matter that can be given.

2. The proposed plan calls for the student's participation in real industrial work and the utilization of his experience there as a source of problems for the classroom.

3. Engineering laboratory work is proposed for the *first* two or three years instead of in the *last* years.

4. Close coördination is required between the scientific courses of the "common core" and the practical work.

5. Emphasis is laid on the problems of values and costs.

6. For short independent courses in the technique of composition, literature, history, economics and so on are substituted humanistic studies extended into a consecutive course carried through the entire curriculum and consisting of live discussions and study of the best that has been thought and said concerning the immediate and the ultimate values in life.

7. Specialization is subordinated to vocational guidance. Because the "common core" gives a student a chance to choose his specialty on the basis of experience, and furnishes the faculty with a broader range of activities on which to base judgment of special aptitudes for particular work, the attention of the faculty is diverted "from the construction of specialized grooves down which the student may be shoved by routine administrative mechanisms, to the study of the personalities, the temperaments and the capacities of young men eager to do the work for which they are best fitted."

As soon as it is possible to measure the results of teaching by impersonal means, successful teaching will be as easy to recognize as profitable research. Objective records of achievement have been found in industry to be one of the best incentives to creative work. Hence the line of progress in education does not lie in the direction of making arbitrary distinctions between research and teaching, but rather in the direction of removing the limitations placed upon the spirit of inquiry, so as to encourage its expansion to include education and human relations generally. Any faculty that will get together and take time to think out its problems can create an organism that will be a live influence in education; and the doing of this will in two years bring more joy to all concerned than forty years of weary effort to maintain things as they are. "The scientific study of industrial education ranks with industrial research as a bond of union between the engineering schools and the industries. On the fuller development of both teaching and research depends the realization of the ultimate aim of engineering education, namely, more intelligent production."

Rapid Precise Levels by Geodetic Survey

Work done in March by a precise-leveling party of the United States Coast and Geodetic Survey near Houston, Tex., represents the fastest precise leveling ever accomplished in this country, according to advices received from the superintendent of the Survey. The new record was made by M. Steinberg and party, in running a line of levels 165.4 miles; the best previous record was made by John H. Peters of the Coast and Geodetic Survey in September, 1916, in running a line of 159.4 miles in Michigan.

In the case of the Texas levels the total length of single line of level for the month was 349.4 miles, as every part of the line was leveled forward and backward and a small portion of length was leveled over three or four times. The accuracy of the levels came within the requirements for high-precision leveling, the highest class of leveling called for by the International Geodetic Association.

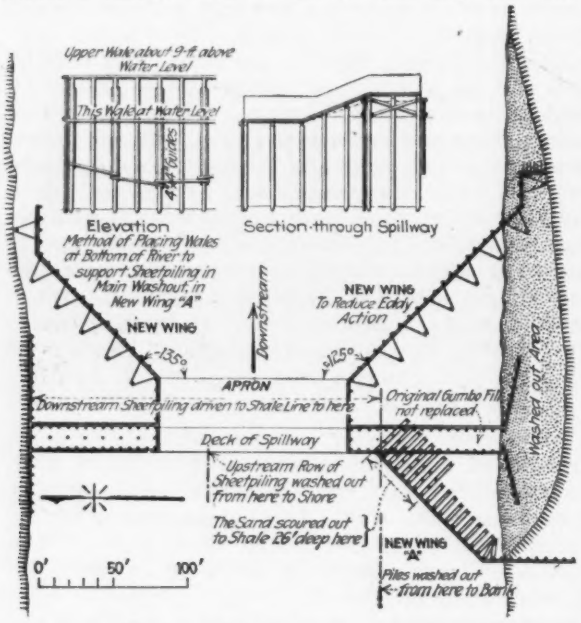
The party traveled by railway motor velocipede car for three weeks of the month, from Mar. 1 to Mar 23. The tripod of the precise level was mounted on the car, as has been the custom in the Survey's precise-level work for several years. The rod readings were recorded on a listing adding machine, also in accordance with recent improved practice. During the fourth week in March, however, an automobile truck had to be used in place of the motor velocipede for transportation, and the instrument was set up on the roadbed.

R. L. Faris, acting superintendent of the Coast and Geodetic Survey, states that no information is available to show that in any other country precise leveling has been done at a rate of progress approaching that of the March performance in Texas of the Steinberg party.

Oklahoma City Wages Strenuous Fight For Water

Farmers Dynamite Dam Diverting Supply, and Engineers Rush Temporary Dam for Use Until New Storage Reservoir Is Available

A WATER-WORKS without a supply was the Oklahoma City plant two years ago, when farmers diverted the river, and again the first of June this year, when a spillway across a diversion was washed out. The Canadian River, from which the city obtains its supply, makes a long loop toward the west side of the city to the present water-works pumping station. Across a narrow neck of land in this loop near the stockyards a cut-off channel was built several years ago, and an earth dam was thrown across this channel near the inlet, so that flood water rising above a certain level could flow over into the cut-off. Reclamation of bottom land upstream by channel straightening increased the gradient so that the flow in the new channel was increased, thereby flooding lands in the vicinity of the junction of the old and the new channels. The construction of a cut-off diversion to relieve land owners near the junction, with its disastrous effects on the water supply of the city, was the next step. By agreement between the city and county officials, the grade of the relief channel was to be maintained 6 ft. above the bed of the old channel, to insure a sufficient flow by the pumping station. The cut-off ditch, 3000 ft. long, was constructed with a base 30 ft. wide on approximately a 0.2% grade, coming back to the old channel at an elevation of 6 ft. above the bed of the old channel. All of the material through which this channel was cut is a fine sand. To protect the ditch against scouring, a narrow concrete wall was constructed, conforming with the cross-section 600 ft. from the upper end. This cut-off wall extended several feet below the grade of the channel and into the slopes of the banks, the shale being about 26 ft. below the grade of the ditch at this point. Soon after the completion of this cut-off channel and the concrete wall across it the river rose, but before it was 2 ft. deep in the ditch the wall had been washed out and the channels widened to an average width of 100 ft. Observing the effect of the flow with this small head of water in the cut-off channel, and knowing that a greater volume of water was coming down the river, the superintendent of the water-works, by quick action in making use of baled hay and sand bags, succeeded in closing the channel across the upper end of the cut-off, thus forcing all the water to follow its former course by the pump station. However, the valley below the new river channel was seriously overflowed and the land owners who were looking for relief were drowned out. During the second flood the water superintendent placed guards on the dam. While parleying went back and forth between city and county officials over the construction of a permanent diversion dam, the third flood came. The land owners became enraged, and on "a dark and stormy night," with a supply of artillery, in true wild-west fashion, they ran off the two armed guards and cut the dam at the middle. With the force of the water, in sandy soil, this gap widened to 25 ft. in a few minutes and to 200 ft. in 10 hours. The old channel and the water-works were left high and dry while the flood went through the cut-off.


Upper Walk about 9 ft. above Water Level
This Walk at Water Level
4x7 Timbers
Elevation
Method of Placing Walks at Bottom of River to support Sheetpiling in Main Washout in New Wing "A"
Section through Spillway
NEW WING
NEW WING
To Reduce Eddy Action
Downstream
135°
125°
APRON
Downstream Sheetpiling driven to Shale Line to here
Original Gumbo Fill not replaced
Deck of Spillway
Upstream Row of Sheetpiling washed out from here to Shore
The Sand scoured out to Shale 26' deep here
NEW WING "A"
Piles washed out from here to Bank
0'
50'
100'

OKLAHOMA CITY DIVERSION DAM WAS REPAIRED WITH PILE WING WALLS UPSTREAM AND DOWNSTREAM

Two attempts were then made to dam this new channel. First, an earth dam was built out to the center where, when all was ready, a wooden gate was dropped to shut off the water. The gate lasted about two minutes and the river pushed out the sand bottom underneath. Second, the remainder of the dam was reinforced with sandbags and light piling, and more sand bags were placed in the middle. This dam lasted 30 min. and then the sandbags melted like sugar. Net results: Six thousand dollars wasted, one man killed by a cave-in of the sand bank, and the city still dry.

STILLING POOL BULKHEAD ON ORIGINAL DAM WAS OMITTED FROM NEW CONSTRUCTION

Toward the end of July, 1916, the problem was again attacked. Wood piles and lumber for a temporary dam and spillway were ordered for a structure that would

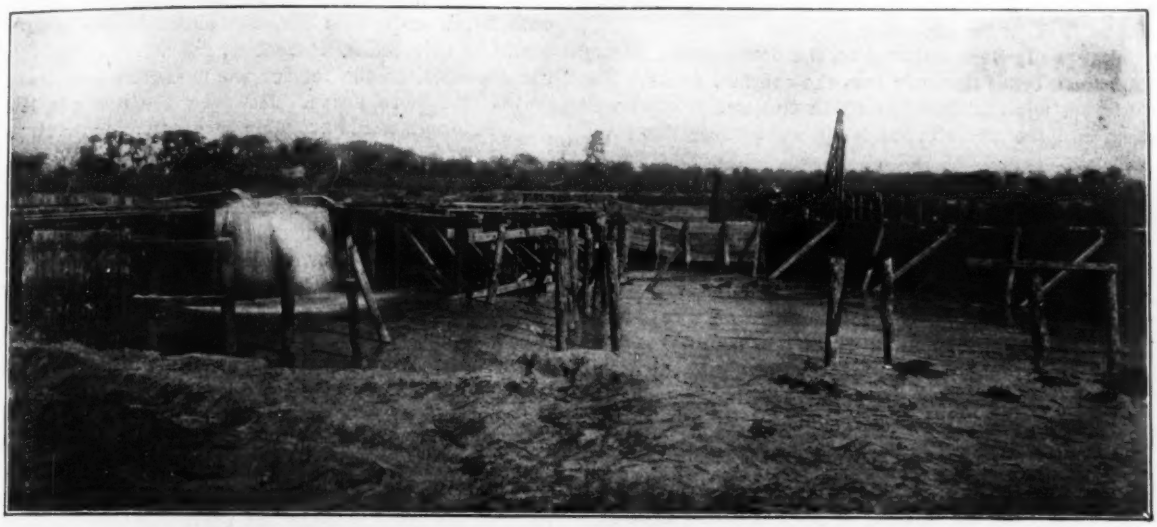
insure a supply to the city until the new $1,500,000 concrete dam and 8,600,000,000-gal. storage reservoir, eight miles away, could be completed. When this new work with the connecting conduit is ready the river can be let back into the cut-off, but high water and labor and material shortages have operated to postpone the date of completion to the end of this year.

Before the spillway dam was completed four motor-driven centrifugal pumps with a capacity of 12,000,000 gal. per day worked on the cut-off channel pumping into the old channel, so that the water would run down to the water plant. The maximum daily consumption during that period was 8,000,000 gal. per day.

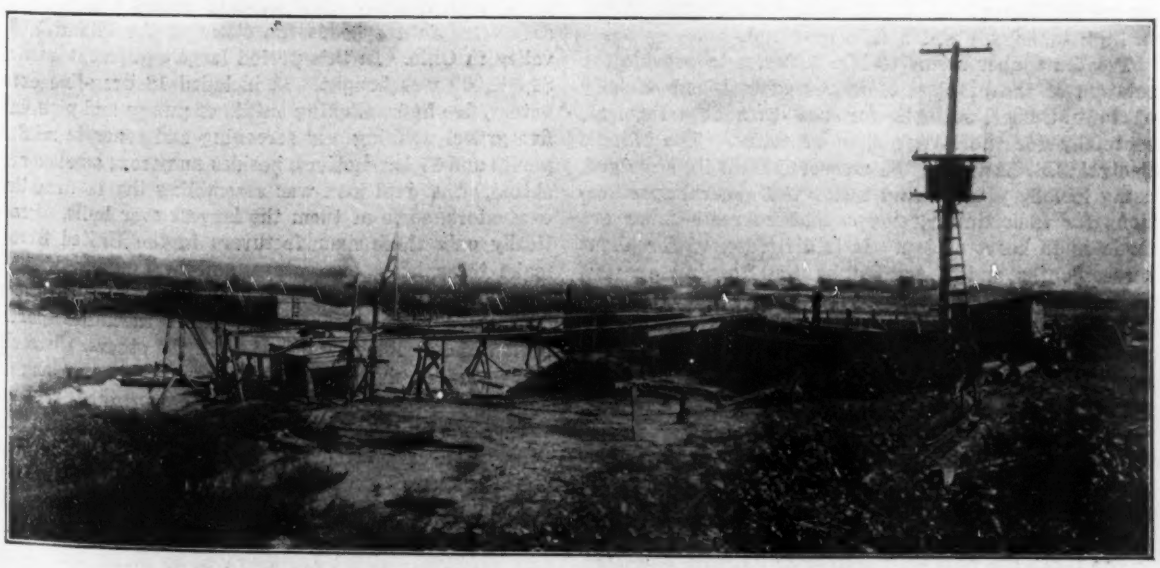
The temporary dam contained 290 piles, 24 to 36 ft. long, driven in a double row across the cut-off, the space between them being filled in with gumbo. This dam is about 460 ft. long. In the center of the dam an extra row is added between the two outside rows of piling. Three-ply sheeting of 2 x 12-in. planks, spiked together and driven tongue-and-groove on the upstream side of the two rows of piling, hold the gumbo. The sheeting was bolted to horizontal 6 x 10-in. wales, in turn bolted to the piling. The timber spillway, which is 34 ft. wide and 130 ft. long, is 6 ft. lower than the crest of the dam. Its approach is of lumber supported on five rows of piling driven upstream for the width of the spillway.

In June of this year the water scoured down to the shale, undermining the round piles and sheet piling at one end, as shown in the drawing. There was again the same rush to set up the 10,000,000-gal. temporary motor-driven pumping outfit, with prayers on the part of the superintendent that this would be the last flood before the new supply is available.

Repairs were made while the water was still running through the gap around the south end of the spillway. At the closure to prevent the sheet piles from being forced downstream at the bottom, an 8 x 8-in. wale was



DOUBLE ROW OF ROUND PILES IN DAM AND HEAD WALL STRIPPED OF SHEET PILING



MOTOR-DRIVEN SAND PUMPS FILLING CHANNEL CUT AT END OF SPILLWAY

submerged to the sand level on the upstream side of the round piles. The wales were bolted to the ends of 4 x 4-in. guides along the round piles. The sheet piles were made up of four-ply of 2 x 12-in. planks, and driven in every case into the shale.

A sand pump was started as soon as the gap was closed, pumping into the wash on both upstream and downstream sides of the piling. A hole 40 ft. wide and 26 ft. deep to the shale had been scoured out. Four rows of piles heavily braced were necessary to hold back the head of water and close the gap.

Wing walls were installed on the downstream side of the apron, tying the ends into the original banks. The upstream wing wall at the south end was started well back into the undisturbed bank, because of the rapid caving.

One of the photographs, taken at point A in line with the double row of piling, shows how completely they were stripped of sheet piling. It also shows the discharge from the sand pumps to fill in behind the upstream wing wall. The photograph taken from point B shows the sand pumping outfit mounted on a raft made of empty barrels, pumping from the sand thrown up when the current shifted from the spillway to the break.

The latest repairs to the break were made under the direction of B. M. Hart, city engineer. J. W. Bennett is the superintendent of the water-works.

Advantages of Wood Water Tanks Under War Conditions Cited

THE economy and advantage of wood tanks under present conditions of steel supply and price were reviewed at the annual convention of the American Railway Bridge and Building Association by C. R. Knowles, superintendent of water service of the Illinois Central R.R. He explained that within recent years the steel tank had been adopted generally for railway water stations, on account of low cost and improved design, together with the decreasing supply of suitable timber. But at present steel is costly and scarce and its use has been prohibited for water or oil tanks, except in high tanks, for which it is essential.

Treated timber seems to Mr. Knowles to provide the solution of the problem of increased cost and scarcity of tank timber suitable for use without treatment, especially for the larger sizes of tanks. The Illinois Central R.R. has made the creosoted tank its standard, using loblolly pine coming under the general specifications for tank timber, except that no restrictions are made as to heart or sap. It is air-seasoned for about three months and is treated by the Rueping process, applying 5 lb. of oil per cubic foot.

All timber more than 1 in. thick is framed before treatment, and it is rarely necessary even to bore a hole during the field erection. Framing and treating are done at the railway's creosoting plant at Grenada, Miss., and the tanks are erected by railway gangs. Presence of creosote in the water is hardly noticeable and has no detrimental effect upon the water. Creosoted timber is used throughout, including the tower, roof and frost box.

The tanks are now built mainly of uniform diameter. Until a few years ago they were usually tapered, following early practice, when hoops were riveted complete and driven down until tight. Sectional hoops put together with lugs and bolts are more satisfactory, especially for the larger tanks, and have eliminated the necessity of tapering the tank. A nonshrinking stave has at the top a deep groove which is filled from the pump discharge. This keeps the top of the staves moist even when the tank is only partly filled.

As to size, a tank 20 ft. in diameter and 30 ft. deep, with a capacity of 100,000 gal., is about the economical limit, said Mr. Knowles. Larger capacity would be obtained by increasing the height rather than the diameter, as the former would require only longer staves and more hoops. However, the cost per 1000 gal. of storage would probably be greater for the larger tank than for two or more 100,000-gal. tanks.

The life of tanks varies with the locality as well as with the kind of timber used. Mr. Knowles stated that timber usually gives longer life when used in the territory where it was grown. Redwood tanks have a life of 26 to 48 years in California and 15 in Wisconsin. White pine tanks have given a life of 35 years in Michigan and 13 years in Missouri. Of 184 tanks in service, the average life has been 32.6 years for redwood, 25 to 32 for cypress, 30 to 35 for white pine.

Standardization of tank hoops is desirable, he thinks, mainly to reduce the quantity carried in stock. A manufacturer who had on hand a dozen types of hoops could not supply hoops that were badly needed until he obtained steel to make the particular type required. Tank hoops are made of round, half-round, oval and flat section. Even with flat hoops, some roads use a varying thickness and uniform width, while others use a varying width and uniform thickness. With a standard type there would be lower cost of manufacture and more prompt delivery.

Search Months for Eighteen Drag-Lines

For three solid months the engineers of the Miami Conservancy District traveled the country for the equipment needed to begin construction on the detention dams and channel enlargements which are to make safe from future floods the cities of the Miami River valley in Ohio. In this period large equipment costing $1,500,000 was bought. It included 18 drag-line excavators, five hydraulicking outfits of pumps and pipe line, five gravel washing and screening and concrete mixing plants and 17 locomotives, besides numerous smaller machines. The real task was assembling the 18 drag-line excavators, some of them the largest ever built. Practically only three manufacturers in the United States make these large excavators, and in January of 1918 two of the three were not in position to produce them. The third manufacturer had three machines partly built which could be obtained. All the others, 15 in all, had to be searched out and purchased from the jobs on which they were then or had been working. One of these came from open-mine work in northern Michigan, three from excavating the Calumet branch of the Chicago Drainage Canal, two from drainage work in Mississippi and the others from nearly half a score of other construction works. Altogether, the 18 machines cost $425,000. Eight are operated by steam and 10 by electric power.

Construction Teamwork Builds "Eagle" Plant in Two Months

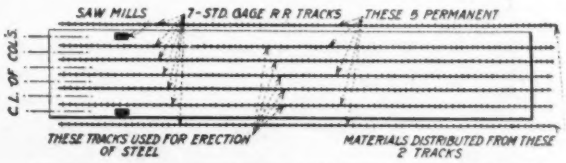
Coöperation and coördination of the efforts of contractors, engineers and architects made possible the early launching of the first "Eagle," by building the River Rouge plant at unprecedented speed. It was realized that the Navy was in urgent need of quick work; cooperation of the highest type and unusually efficient field organizations were vital elements in producing the result. Accounts of how the work was done, obtained from the general contractor and the steel erector, throw a clear light on the spirit of drive, the organizing ability that created the "Eagle" plant. These accounts, summarized by the editor, are given here.

Contractor's Preparation and Efficient Organization Speed Work

ORGANIZATION, coördination and coöperation of construction men and methods explain the success of driving the boat-building plant of the Ford Motor Co. to completion in a few months. Owner, architect and contractor were represented on the job by men capable of deciding, and with authority to decide immediately, any question of construction procedure which arose. A systematic construction plan was worked out and executed by a closely knit organization of superintendents and foremen, each in charge of a specific operation or group of operations, and all responsible to the trinity of owner, architect and contractor through a general superintendent of construction. Scheduled performance was planned and adhered to with exactness. Construction was resolved into elements of work involved, and crews were organized to perform each the specific set of tasks constituting an element of work.

Eighteen acres of buildings, stretching in line a mile along the River Rouge, house the boat-building operations of the Ford Motor Co., at Detroit, Mich. The structures included are: A punch shop, an assembly shop, two fitting-out sheds, a transfer table, a launching bridge and several service buildings. Construction of these structures required the placing of 25,000 cu.yd. of concrete, 4150 tons of structural steel, 3,500,000 ft. b.m. of lumber, 1,250,000 brick, 185,000 sq.ft. of steel sash and 480,000 sq.ft. of cement tile roofing. About 2000 men were employed at the height of construction operations.

Construction of the punch and assembly shops, buildings of very large size, was the governing operation. The punch shop is 160 x 600 ft., and the assembly shop 305 x 1700 ft.; both have brick walls and wood floors; but while the punch shop is a simple timber-frame structure, the assembly shop is a steel mill building with tile roof. Technically, the buildings offered only


SAW MILLS
7-STD. GAGE R.R. TRACKS
THESE 5 PERMANENT
C.L. OF COLS.
THESE TRACKS USED FOR ERECTION OF STEEL
MATERIALS DISTRIBUTED FROM THESE 2 TRACKS

SEVEN TRACKS BRING IN MATERIALS AND CARRY ERECTING CRANES

the simplest of erection problems; no machine or method out of the ordinary was needed for assembling or erecting any part. The construction problem lay in the volume and area of the operations and in the speed of erection required. For example, the assembly shop involved the erection of 86 transverse rows of columns, and the total steelwork comprised 516 columns, 430 trusses, 8400 purlins and some 8000 miscellaneous bracing members.

Preliminary preparation had much to do with the quick start of construction. As soon as it became apparent to the contractors that they were likely to obtain the contract, they began preparations to jump immediately into actual construction operations. Stock was taken of all the organization available or which could be made available for the work. Local dealers in builders' supplies were rounded up and lists made of all their available stock. A construction organization was designed, and the men for the various positions were selected. In the same manner plans were made for a construction plant and the necessary equipment units were located for immediate shipment. Plans were then formulated for carrying out all construction operations, schedules of required materials were made up, and time of delivery determined. Study was made of the site, with reference to quick commencement and rapid prosecution of construction operations, developing two broad facts: As the site was eight miles from Detroit and two miles from the nearest car line, ample means must be

PARALLEL SERVICE TRACKS COVER ENTIRE AREA OF ASSEMBLY SHOP

provided at once for transporting workmen to and from the work. The ground, while comparatively level, would be too wet and soft for hauling, once the spring thaw, which might be expected any time, had taken out the frost, so that road construction had to be started at once. Thus, so far as was practicable, all problems were determined and the methods of solving them were decided upon before the contract had been signed.

Construction started with a jump. Contracts were signed late Friday afternoon, Feb. 15. Immediately,

MIXER CREW CONCRETES FOOTINGS CLOSE BEHIND EXCAVATING GANGS

by telephone and telegram, men and equipment already selected were ordered into the work. Delivery of gravel, sand, cement and anchor bolts for the foundations began Saturday morning. On Sunday surveyors were establishing grades and staking out the punch shop site. Excavation and foundation construction began Monday. Meanwhile, from the lists already made up, material had been ordered for the punch shop, and enough for a good start on the assembly shop. At the same time several hundred carloads of cinders for roads were rushed to the job and distributed by large steam tractors and trailers. Lumber for the punch shop began to arrive Monday from local dealers. This was the start.

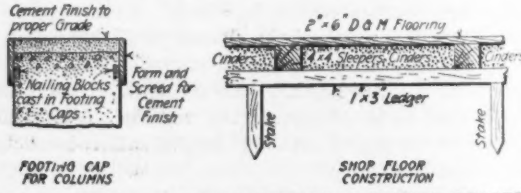
Material and labor supply was the first big problem. By means of the definite schedules of construction operations and the material lists previously prepared, all materials were ordered so that delivery would be made as the various kinds were required for construction. To insure shipment and delivery according to schedule, the Government gave special priority to all shipments, and the Ford Motor Co.'s highly organized traffic department was placed at the disposal of the contractors. As this organization has men stationed at practically all transfer points throughout the country, all cars could be traced and located quickly and their progress checked, so that all possible delays in transportation could be avoided.

Inter-job handling of materials was accomplished by railway tracks lengthwise of the building sites. From these tracks most of the materials were unloaded so close to the point of use that they could be handled directly into place. Where this was not possible, teams, motor trucks and tractors distributed the materials.

Labor was recruited by all the usual methods. First the contractor drew on his own forces; then, by advertisements and by canvass of the labor agencies, this nucleus was added to. The workmen assembled each morning at a point in the city and were transported by motor truck to the job and brought back in the evening free of charge, until a line of specially-built buses was established by the Ford Motor Co. to make connection with the nearest car line.

Construction organization and procedure were substantially the same for the two main building units. The chart shows the construction organization. Work was begun first on the punch shop, and when this was finished the organization there was absorbed into the assembly shop organization. Construction was begun on both buildings at their north ends, and proceeded in successive across-building zones, one operation following another as closely as was practicable. Approximately, the order was as follows: (1) Excavation for column and wall footings; (2) footing construction; (3) frame erection; (4) lean-to roof construction; (5) sash setting, glazing and tile roofing; (6) floor construction. Brick-wall construction proceeded separately but in progress with the other work, keeping ahead of the lean-to construction and sash setting.

The assembly shop erection illustrates the construction procedure in detail. Seven lines of standard-gage railway track run lengthwise of the site, as shown by the sketch. Excavation for wall and column footings by a special gang was begun first and proceeded in zones across the building. While excavation was going on the footing cap forms were being made ready. A concreting gang followed the excavating gang and poured the

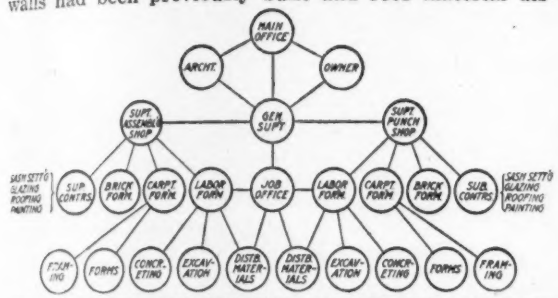


SPECIAL CONSTRUCTION METHODS HASTENED PROGRESS ON FOOTINGS AND FLOORS

footings, except the caps. This gang was followed by carpenters setting the cap forms and the anchor bolts. Another mixer gang with small portable mixers concreted the caps. Following this gang came a crew of carpenters putting on screed boards for finishing the column bearings to true grade and level, as shown by the sketch. This last operation made the footings ready for steel erection.

Immediately upon arrival of the steel four or five bays were erected, and then all hands were set to unloading cars and distributing the steel along the site, as shown

by the picture, in the position most advantageous for quick erection. In the meantime, the bays first erected were being permanently connected up by the riveting gangs, so as to get a start on the succeeding lean-to construction, roofing, sash setting and floor construction. Construction of the lean-to roof was then begun. The walls had been previously built and roof material dis-



CLOSELY KNIT CONSTRUCTION ORGANIZATION INSURED COÖRDINATION OF DIRECTION

tributed along the work. Placing the main building roof and sash setting and glazing followed.

As soon as enough of the building had been inclosed floor work was started. The floor consists of plank and sleepers, on cinder fill. As shown by the sketch, stakes, carrying ledgers held the sleepers at grade while the cinders were tamped in place. Then the planking was placed.

By these successive operations the building was completed in transverse sections. In fact, the first operations of assembling boats had commenced at the north end before the south end was under cover. Forty days after the first bays of steelwork were erected the completed building was turned over for occupancy. and the first chaser keel was laid 79 days after construction began. So closely did the successive operations follow each other that in 15 days after the last steel was connected up the entire building was completed.

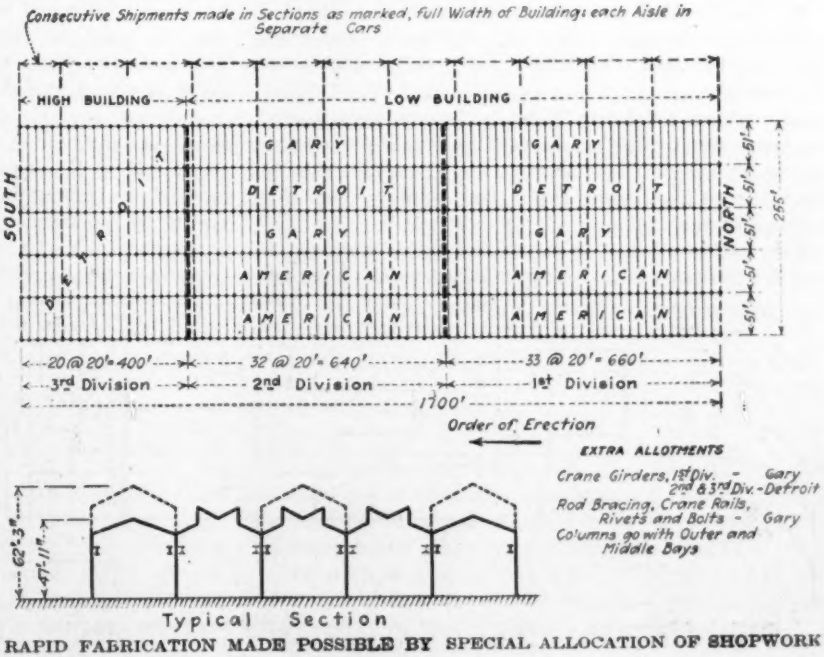
As fast as plant and men had finished their work on the assembly shop they were transferred to the foundation work on the transfer table, to the general contractor's portion of the launching bridge construction, and to the fitting-out sheds and the various service buildings. Time-scheduling all operations was a very important factor in maintaining speed of construction. This scheduling was applied not only to the general contractor's gangs but to the crews of the subcontractors. Also material deliveries for subcontractor's operations were followed up as closely as they were for the larger operations of the general contractor. In emergency, men were supplied to the subcontractors from some less important work of the general contractor. In fact, the policy of shifting workmen as occasion demanded was followed throughout the construction operations. If some part of the work was falling behind men were immediately transferred from another part to speed up the lagging operation.

Team work, following a careful study of the requirements of the job and of means of anticipating them, was the method employed to speed up construction. Team work was not limited to the directing heads of the construction operations; there was also wonderful coöperation on the part of the workmen. The superintendents and the foremen were animated with the feeling that they were not working alone for so many dollars' profit, but to help the Government win the war. This spirit permeated the whole working force, from water boy to the highest official. Evidence of this was shown by the manner in which the men worked under conditions which no mere money inducement could have made them endure.

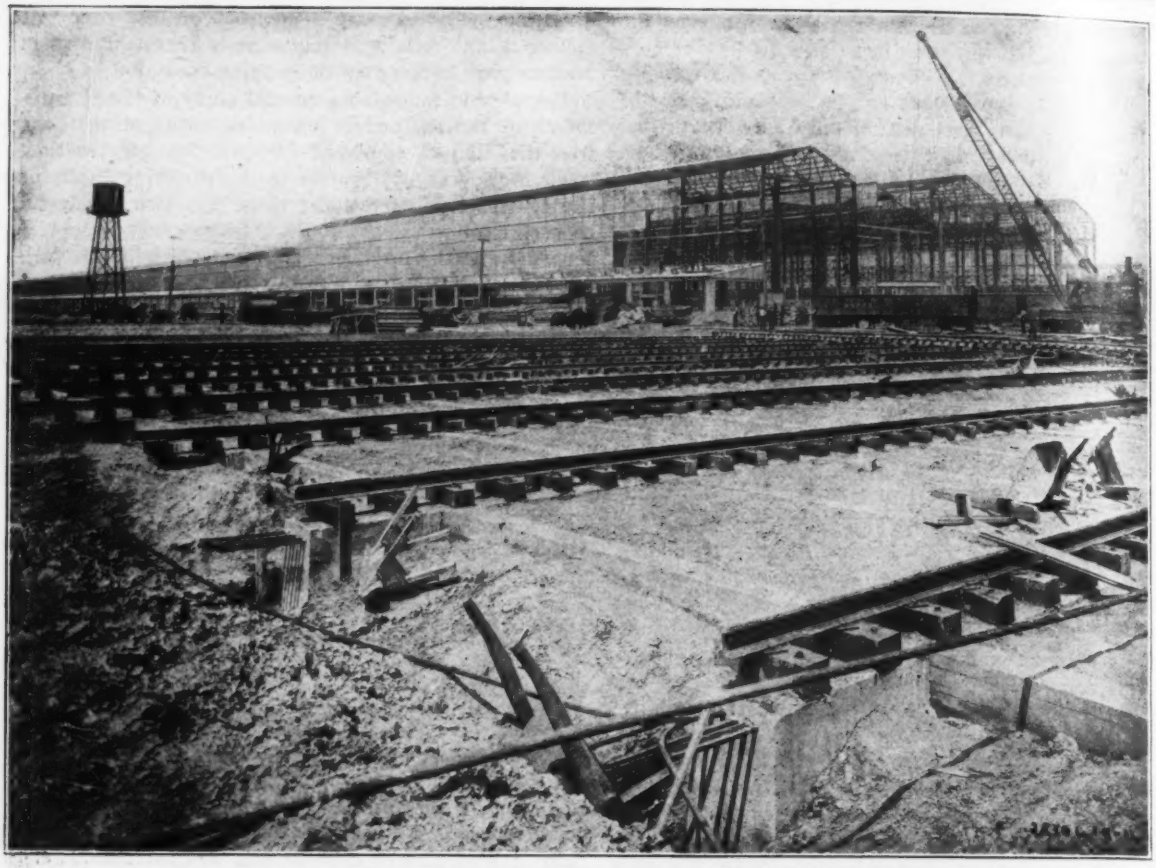
The H. G. Christman Co., Detroit, Mich., and South Bend, Ind., was the contractor for the work described. The work was done for the Ford Motor Co. under the direction of Albert Kahn, Detroit, Mich., who was the architect.

Fast Steel Erection Due to Joint Drafting Room, Shop and Field Work

FORTY-TWO hundred tons of steel, the frame of the 300 x 1700-ft. assembly shop, had to be erected in four weeks' time in order to carry out the rush construction of the Ford submarine-chaser plant at River Rouge, near Detroit. The task set called for unprecedented speed. By hard driving, on the basis of a carefully studied plan of operation, it was carried out successfully. On Apr. 13 the American Bridge Co.'s erection forces set the first piece of steel; on May 11 they set the last, and a few days later finished the riveting and left the ground. A leading official of the company says, "It was a little bit faster than any other erection work we have done."



RAPID FABRICATION MADE POSSIBLE BY SPECIAL ALLOCATION OF SHOPWORK



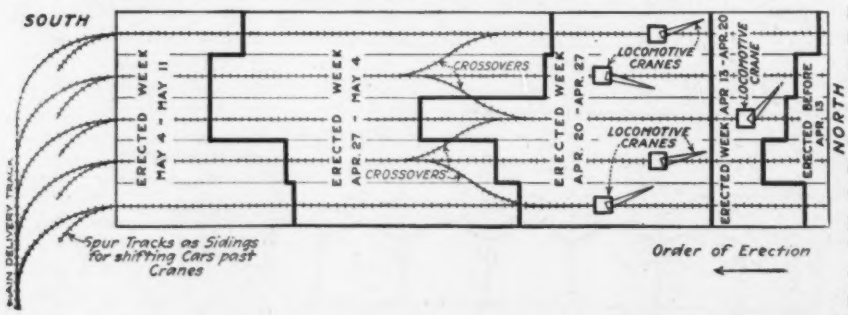
SHIPBUILDING STARTED IN FINISHED NORTH END OF SHOP, ERECTION BEING RUSHED AT SOUTH END; STEEL FRAMING JUST COMPLETED

Rush methods started the moment the contract was awarded. The performance was made possible only by the arrangement of the entire work from mill to erection on a single general plan laid out for speed.

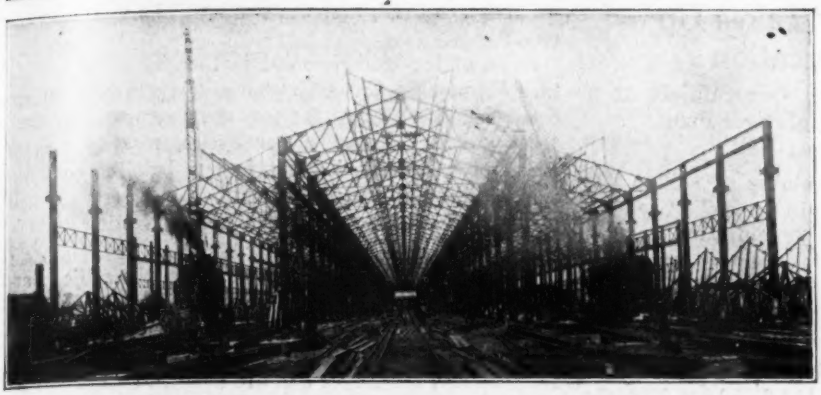
All the working drawings were completed, checked, and put into the shop within fourteen days, by close cooperation between Albert Reichmann, western division engineer for the bridge company, and J. T. N. Hoyt, chief engineer for Albert Kahn, architect. Details were approved and drawings checked by Mr. Hoyt directly in the company's Gary drafting room, as fast as they were turned out, and prints then went to the shop without further delay.

Fabrication of the steelwork had to be arranged to suit the erection plan. As a much larger field force and more equipment were to be used than are employed on a similar building under ordinary conditions, the order of work necessarily was different, and the shops had to fabricate and ship accordingly. Absolute coördination of all units engaged in the work was essential to meeting the schedule. Because this coördination was obtained, the erectors were able to set the steel in the building virtually direct from the cars.

Although the size of the building resulted in an unusual amount of duplication, fabrication had to be divided among three plants in order to save time, and part of the saving in duplication was lost. Economy had to be sacrificed to speed. In order that the erectors might be able to carry the whole width of the building forward at an even pace, the plants had to work on separate longitudinal slices of the structure. The allotment of fabrication was made as indicated in the plan shown, the five bays being distributed among the three plants as noted. The length of the building was cut up into three divisions, each to be completed before the next division was started. That a remarkable degree of coördination in the shopwork was obtained, and thereby record-breaking speed of fabrication, was in large part



FIVE LOCOMOTIVE CRANES WORKING DOWN THE FIVE BAYS ERECTED ALL STEEL IN FOUR WEEKS



LOCOMOTIVE CRANES ERECT STEEL IN SUCCESSIVE TRANSVERSE BAYS

due to the constant efforts of E. A. Smith, western division operating manager for the bridge company. Fabrication and shipment took only five weeks. Both the order and the rate of shipment were closely adjusted to the requirements of erection, except that during the first week or two of the erection period the steel arrived at such a rate that the erecting force had to stop for a time and turn all hands to unloading material, in order to clear up the congestion of cars. Five erection crews were put into the field. Each was assigned to one of the five bays, and operated a locomotive crane down the center of its bay. A track was laid down each bay, with crossovers between tracks at mid-length of the building and at the far end. This layout proved extremely convenient in handling material and shifting cars and cranes.

Shipments of steel were received in sections of eight panels each. The material for each of the five bays was sent in separate cars, moreover. It was therefore possible to distribute the material exactly as needed and, as each following shipment contained the material next in order of erection, no difficulties or delays chargeable to piling or storage resulted. The columns were, in general, taken direct from the cars and erected. The rest of the material was unloaded at the point where it was to be used, in order to release the cars and clear the tracks. The 51-ft. trusses, designed of such depth as to permit shipment in vertical position, were riveted up complete at the shops and were shipped in sets of eight on three flat-cars.

After the preparatory period on the ground, during which a few columns and trusses were erected, erection began in earnest on Saturday, Apr. 13. The start was made with a rush, but work was soon delayed by the arrival of several shipments of steel simultaneously, after previous delay in transportation, and unloading took part of the force off the erection. With the accumulated material ready for the cranes, the following week was very active. Even bigger tonnage was handled in the fourth week, the heaviest week of the entire job, 1400 tons being erected. Material crowded the men throughout the field work, and this was a main factor in getting rush work by the erection crews. A special case that occurred on the job illustrates this effect. For a period of several days only four of the erection crews were at work, the other crane being put to unloading material. This bay got so far behind that when the crane resumed erecting it made remarkable speed in the crew's effort to catch up with the others and get ahead of the stored material. Twenty-two trusses and their purlins were set by this crew in a single day—a marvelous performance, in the opinion of steel erectors.

Getting together the large erection force and equipment required was a matter of serious anxiety at early stages of the job, due to the large amount of work already in progress. J. L. de Vou, central division erection manager for the American Bridge Co., who was in direct charge of the work on the ground, found himself with only 10 men to start the work, owing to the great drain of this class of skilled labor to other industries. By energetic efforts, however, the company succeeded in assembling within ten days about 250 men, all experienced bridge erectors.

STEEL DISTRIBUTED ALONGSIDE CRANE TRACKS READY FOR ERECTION

The maximum working force at any one time was about 170, and the average force throughout the job was about 150 men. This included four or five riveting gangs. The total number of rivets used, slightly over 30,000, was small in proportion to the size of the building.

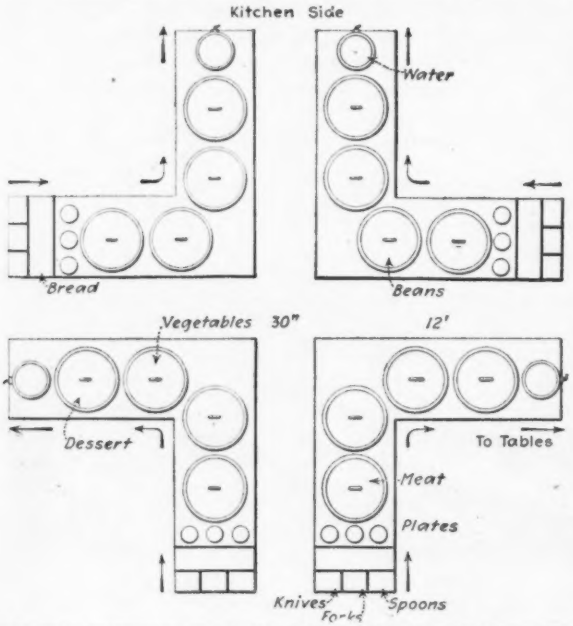
Only the truss connections to the columns and the crane-girder connections were riveted—this to provide the desired degree of stiffness in the structure—while all bracing and other connections were bolted.

The work was under the general direction of C. W. Bryan, chief engineer of the American Bridge Co., and Richard Khuen, Jr., general manager of erection.

Commercial Body Takes Up Vocational Education

Classes in Indianapolis Taught One Subject at a Time Until Mastered—Cafeteria Plan Saves Time in Mess Hall

FOUR detachments for the training of skilled mechanics are maintained by the Indianapolis Chamber of Commerce This commercial organization handles the eight-week training problem taken up by many universities and engineering schools in practically the same manner as they have. It has taken over the State School for the Deaf, the State School for the Blind, an entire hotel, the vocational facilities of two high schools and the state fair grounds. Courses are given for mechanics, chauffeurs, blacksmiths, electricians, gunsmiths,



LAYOUT PERMITS SERVING 580 IN EIGHTEEN MINUTES

carpenters and woodworkers, sheet metal workers, telegraphers and radio operators. The city's vocational director was obtained, and some of the best men in the factories of Indianapolis were released to act as instructors.

Many thousand dollars' worth of motors and other equipment was loaned for the use of the instruction staff. The Chamber of Commerce organized an instructional staff of 125 men, purchased equipment and contracted with the Government for the housing and subsistence of 1100 men. The schedule of work on the student's part consists of six to seven hours' vocational work per day and three hours of drill, with Maj. J. D. Crawfis as commanding officer. This autumn, when the high school buildings were required for their regular students, the contingents were removed to the State School for the Deaf. Additional barracks, a mess hall and a power plant have been installed to care for a maximum of 1800. The regular students for this institution number only 220, and they are asked to remain home for this school year, at least. The equipment and grounds are ideal, and the plant will be used to capacity.

Some of the work handled in the city as instruction includes putting 250,000 rough gun-sights into finished condition, overhauling for two army camps all of their trucks, side-cars and motor cycles, making garbage cans, tools, springs, helping in war building construction, cleaning up and salvaging machinery and all kinds of material after a serious fire, and harvesting grain in record time.

As at the University of Pittsburgh, the subjects are presented always with the actual object under consideration in hand, but not so much stress is laid on assembling and dismantling. Classes in auto mechanics, for instance, are larger and are handled almost entirely by technical graduates. The work is divided into departments such as ignition, carburetor, steering, transmission, repair, motor, driving and "trouble shooting." The time spent in each depends on the speed with which the average man gets a grade of 3 out of a possible 5. Carburetion takes five days, but the remaining subjects usually take less time.

There are 63 technical instructors, each expert in certain lines. The remainder of the instructional staff is recruited from detachments gone before. Many of these men will eventually be sent to officers' training camps. Each of the four detachment points has trained one set of men and are on their second unit. No. 1 at the hotel building is on its third contingent of 500 men.

The gunsmith training, typical of the carpenters, and wood and metal workers, is divided into a series of seven different steps in the course, each given for a week. The work is done on various floors of the Dolman Building. Each class of 19 men is given an instructor. Class 1 includes chipping and filing; 2, patching, countersinking, drilling and filing taper pins; 3, keyways, making geometrical shapes from sheet metal and cylinder patching; 4., rifle assembly and small-part repair; 5, babbitting, spring hardening and all kinds of forge work; 6, bicycle assembly and general repair of miscellaneous machines.

Mess hall arrangements at the State School for the Deaf are on the cafeteria plan. The hall will seat 580 on the ground floor and 540 on the second floor. The men march in from three sides to a central station of four tables, arranged as shown in the sketch. The men are helped to everything except bread and water. The usual time for meals is 30 min.; 10 min. of serving and 10 to 20 min. of eating. The men leave irregularly. The time has on occasion been cut to 18 min. Tables accommodating 10 men each are set up with cups, coffee pots, vinegar, sugar bowls, salt and pepper, the commissary department hiring 60 employees to handle the 100 students. The tables are of the ordinary contractor's camp type with attached seats on a 2 x 4-in. scantling nailed to the table legs.

Four canteens are maintaned, all profits going to the entertainment funds. Both the Y. M. C. A. and the Knights of Columbus have established recreation centers as at regular army posts.

Ernest N. Smith, secretary of the Indianapolis Chamber of Commerce, is business manager of the schools, and E. C. McCullough is assistant business manager.

Expect Increased Use of Machinery on Iowa Road Maintenance

Will Cover More Mileage With Fewer Men—Shortage of Labor and Limited Funds Due to the War Enforce Economy

HIGHWAY maintenance methods in Iowa have to be developed on economical lines, as the funds available at this time for this work are small in proportion to the mileage of roads requiring to be maintained. Machinery is used to some extent even for dragging, and it is expected by T. H. MacDonald, chief engineer of the State Highway Commission, that next year many more small tractors and motor trucks will be employed on this work. As compared with teams, such equipment will, it is thought, allow heavier drags to be used and a larger mileage of roads to be covered with a smaller number of men.

Maintenance organization includes road gangs, road patrolmen and road draggers. For the gang system the most economical method is found to consist in the use of a tractor pulling graders with one blade or two. A tractor with two graders requires three men, and preferably a team and driver, for hauling supplies and doing odd jobs. Most of the country roads have been built to standard cross-sections, and it is found desirable to have the tractor outfit go over each mile once in two years. At that time the gang cleans the ditches, reshapes and builds up the shoulders and leaves the road in condition for dragging. With good equipment and an experienced crew very economical results are obtained, it is said, and the roads are left in good condition for travel.

MANDATORY PATROL

A mandatory road patrol law, under the immediate direction of the county boards, exists in Iowa, and a road-patrol system is being built up. The patrolman is equipped ordinarily with a team, wagon, hand tools and small grader. He does not do all the dragging, but endeavors to keep the roads in shape and true to section by the use of the small grader, and makes small repairs, in addition to the maintenance work. In dry weather he is ordinarily employed in hauling gravel. The patrolman also has charge of the draggers on the roads under his jurisdiction. In some counties small tractors or light motor trucks with two men each are being used for the repair work.

Road draggers, who work short sections of road after rains, form the third factor in the maintenance system. In practically all cases these men are local farmers having teams available for this work. At the present time, however, owing to the lack of farm labor and the difficulty of getting the roads dragged at proper times, the commission is trying small trucks, which are expected to prove satisfactory and economical for this purpose.

Organization for road maintenance is not very definite, varying with the places. No considerable mileage is maintained where all of the three methods named above are employed in the order and for the purpose for which they are most suited.

Bridge and culvert improvement has progressed so well for several years that there is now no great difficulty in maintaining them on the principal roads. There are important structures, however, the building of which will have to be deferred. It is even possible that in isolated cases unimportant and little used roads will have to be closed on account of bridge conditions, but the program carried out for the past five years has made it possible to curtail new construction very materially without closing important roads.

Suspension Bridge Aqueduct Twice Built in Six Weeks

Quick Construction Work With Makeshift Materials and Plant Saves War Crop from Drought in Wyoming

BY F. C. EMERSON
Superintendent Big Horn Canal Association, Worland, Wyo.

RAPID emergency construction methods restored last year in 30 days a 250-ft. irrigation aqueduct which had been swept away by a flood in the Big Horn River. A second collapse, just as the first restoration had been completed, was repaired, by salvaging the fallen structure, in 16 days. Construction materials had to be gathered from a dozen places where available, and in some cases it was possible to obtain only makeshift materials. Progress was further handicapped by a swollen stream and by intensely hot weather. By restoring the flow of water in a little more than six weeks a considerable portion of the crops on 12,000 acres of irrigated land was saved.

Upper Hanover Canal, on which the accident occurred, crossed the Big Horn River about 16 miles above Worland, Wyo., by a steel flume on steel trusses over 80-ft. spans caried on concrete-filled, twin-tube piers. Flood water on June 20, 1917, destroyed the bridge structure, apparently by undermining one of the piers. The length of aqueduct destroyed was 239 ft. The construction problem was to restore this gap and to do it quickly, as the preservation even in part of 12,000 acres of crops depended upon the quick restoration of the water flow.

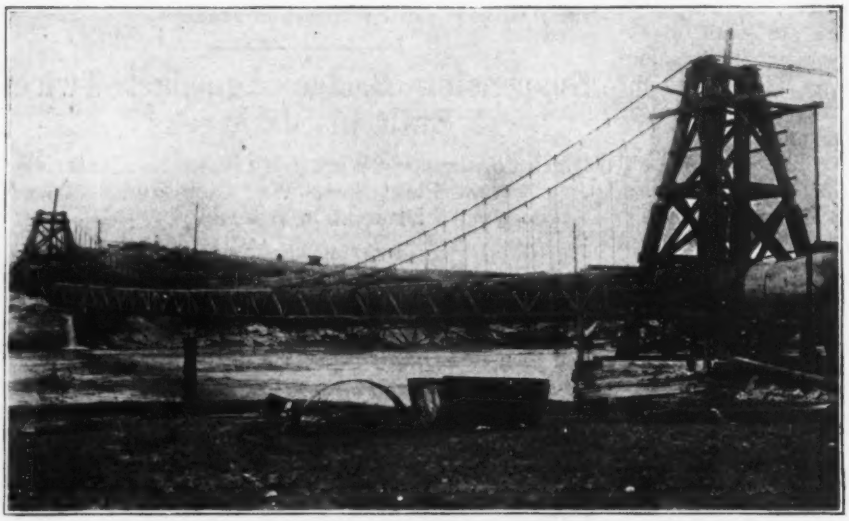
The time that would have been needed to obtain and install a pumping plant large enough for the service required placed this solution out of consideration. Timber trestle construction was dismissed because of the uncertainty of the piles holding on portions of the river bottom where rock outcropped. It was finally decided to construct a suspension bridge.

Two lines of 2¼-in. cable, 6 ft. apart, carried on wood towers and anchored to a concrete deadman on each bank, formed the main suspension element. Hung 4 ft. apart from the cables ⅞-in. rods carried 8 x 8-in. timber sills braced together by a lateral system of 4 x 4-in. timber horizontal and diagonal members. Stiffening trusses 4½ ft. deep, consisting of 4 x 6-in. chords, 4 x 4-in. struts and ⅜-in. ties, were bolted to the sills and braced together across the top. The pipe was 4-ft. ingot iron pipe resting on the sills and having a 10-in. expansion joint at midspan.

Since it was probably the cause of the second accident, one detail of the main cable construction deserves special mention. At the west shore anchorage the

fastenings for the cable lines are 4-in. round forgings. The 2¼-in. cables lacked 42 ft. of reaching to these forgings. To fill the gap eight strands of ⅞-in. galvanized cable were rove between the forging and the 2¾-in. U-bolt through the socket on the end of each cable.

The company was without equipment of any kind, it was very difficult to obtain materials for construction, and the high stage of the river and the intense heat that prevailed all added to the difficulty of the work. It was found necessary to take such materials as were then available, rather than wait for such as would be best suited to the work. Obtaining the necessary cable was the first hard matter, for the Government had called into use for submarine nets practically all of the idle supply of large cable in the country. However, a supply of 2¼-in. steel cable, of one of the best grades, in very good condition and sufficient in amount to provide two lengths, was finally found in the yard of a Denver dealer in second-hand materials. Before leaving Denver this cable was cut into the required lengths and the ends were bushed and babbitted into standard closed sockets. Hangers of ⅝-in. rods, with the necessary fittings, cast saddles to carry the cables over the towers, and other parts, were made up in Denver and, together with the cable, were shipped to the work by express. The required amount of 54-in. ingot iron pipe was also made up in Denver and hastened to the work.



SUSPENSION BRIDGE AQUEDUCT REBUILT TWICE IN SIX WEEKS

Valuable assistance was rendered by all agencies in the vicinity of the work that could be of service. From the Wyoming Sugar Co., then constructing a factory at Worland, heavy timbers were obtained for the towers and other parts of the work; the Monarch Engineering Co. supplied rods for U-bolts, tools and men; the Big Horn Canal Association, materials and equipment; the Lindstrom drainage force sent a crew of muckers used in the excavation of the deadman pit on the east side of the river; and from many others anything that would help the work.

The flume was wrecked the night of June 20. Four days thereafter were consumed in deciding upon the type of structure and in gathering data relative to the availability of materials for construction. It was then necessary for the engineer, accompanied by the president of the water users' association, to make a hurried trip to Denver in the interest of getting materials and equipment for the work. Actual work on the ground was started June 29. After three weeks of intense effort the workers turned the water into the completed structure July 20, only to see the west end of the structure plunged into the river by reason of the failure of one of the lines of ⅞-in. cables connecting the main cables with the deadman on the west side of the river. When the second failure occurred the west tower was overturned into the river, about half the pipe was twisted or bent out of shape, and the stiffening trusses and other woodwork were considerably damaged. Work was immediately resumed. The structure was fished from the river; the task was attended with much difficulty by reason of the high stage of the water that yet prevailed. As considerable delay, it was held, would occur in replacing and repairing the damaged iron pipe, it was decided to substitute 48-in. wood-stave pipe, a supply of which was available within hauling distance. In the reconstruction the ⅞-in. cables on the west side were replaced by 42-ft. U-bolts, two on each line of 1⅞-in. and 2-in. diameter; also 1¾-in. U-bolts were added to the deadman ties on the east side of the river, to overcome any weakness on the part of the sets of four strands of ⅞-in. cable used. The remainder of the structure was repaired and rebuilt as before.

After considerable delay in waiting for the heavy U-bolts, the structure was complete and water turned in on Aug. 5. The head was turned out again, long enough to allow of the readjustment of some of the hangers. A full head of water was finally turned across the river Aug. 7.

Six hours were allowed for the first loading of the pipe, in order that all parts of the structure might have sufficient time to adjust themselves properly. On later occasions, when trouble elsewhere on the canal caused the partial unloading of the pipe, the reloading was performed without any particular checking of the flow in the canal. The continuous stave pipe, with ½-in. bands spaced 10 in. apart and with double spacing at the lapped joints, proved an excellent waterway, as the pipe combined great strength with the elasticity so desirable in such a structure. After 24 hours of service no leak of any consequence was shown. A heavy wind which struck the loaded bridge shortly after its completion and before the ½-in. guy lines, later added, were in place, produced no lateral vibration of amount, although when another heavy wind a short time later struck the bridge with the pipe unloaded, a sway of 4 or 5 in. was produced. At the east end the pipe

was free to move back and forth in the round end of the transition section of ingot iron, water-tightness being obtained by the well packed joint of oakum.

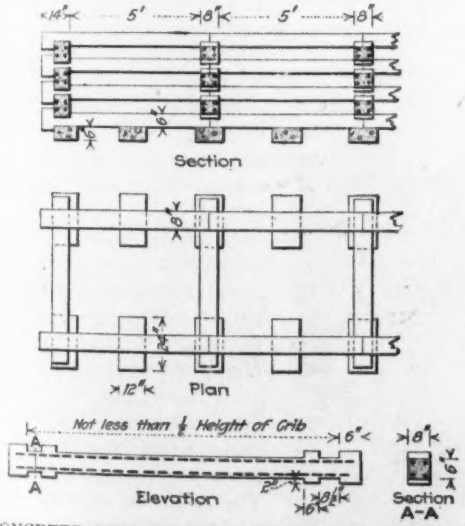
The work was all performed under force account, under the direction and supervision of the writer. It cost $20,000. In connection with the engineering features of the work the writer was advised in different phases by C. C. Madser, of the Monarch Engineering Co., N. A. Lockwood, of the Wyoming Sugar Co., and F. N. Cronholm, of the United States Reclamation Service.

Precast Concrete Lumber Forms Cribs To Retain Fill

Oregon Highway Commission Finds Cribwork Useful as Retaining Walls in Side-Hill Road Work

PRECAST concrete units are being used by the Oregon State Highway Commission for cribwork to retain fills on sidehill roads. The cribs are designed for use where the height of the walls desired is between 6 and 16 ft. The width of the base is not less than half the height. The structure is founded on mud sills 1 x 2 ft. in plan and 6 in. thick. On these mud sills are placed alternately tiers of longitudinal members and cross ties, each of which has notches that permit of interlocking the members. For convenience in casting and handling, the longitudinal members and cross ties are usually made of the same length, the length of the cross tie being determined, of course, by the height of the wall to be built up.

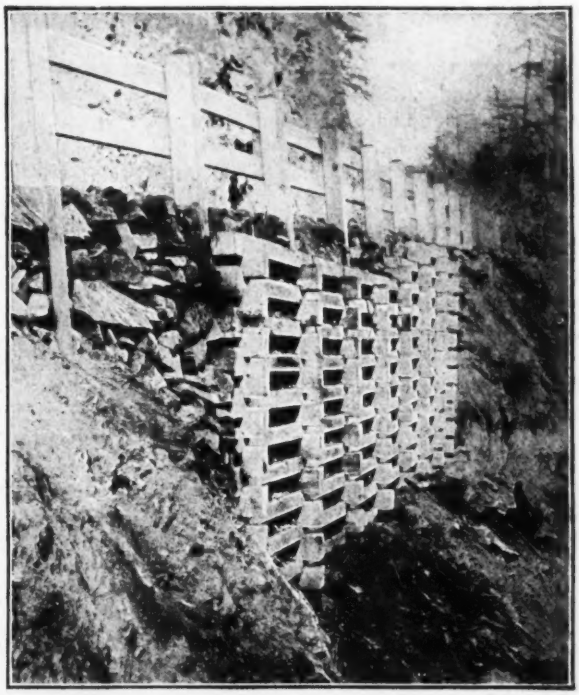
All the members are reinforced with ⅜-in. rods placed about 1 in. from the face of the concrete. The members are usually made of 1:2:4 concrete and 6 x 8 in. in cross-section. In the use of this type of



CONCRETE LUMBER USED IN MAKING CRIBWORK

crib it was found that the outside face should have a batter of at least 1 in. per foot, and transverse members should be set normal to the face. After the crib is completed it is filled with rock as in the crib of ordinary timber construction.

The plan has been worked out and applied under the direction of Herbert Nunn, highway engineer of the commission. Cribwork has this advantage over monolithic construction, that it does not show cracks under



CONCRETE CRIBS BOTH PERMANENT AND FLEXIBLE

uneven settlement, but timber cribs have so short a life that their use is not economical. The concrete lumber should prove acceptable in this respect.

Road Work Set Back Ten Years in England

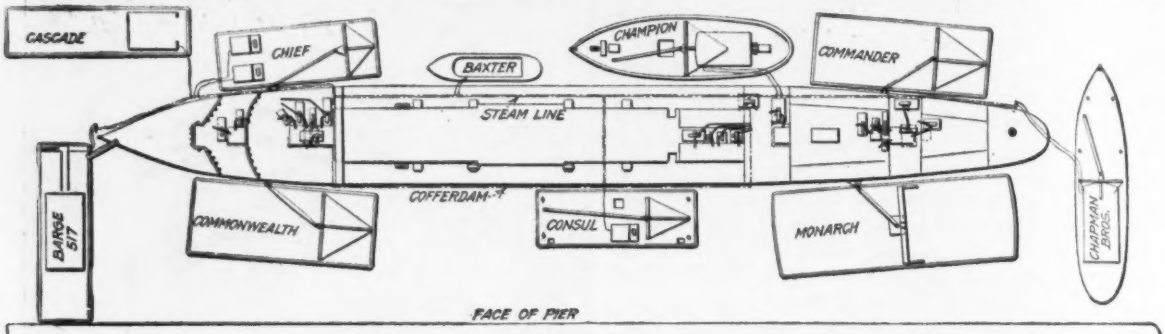
That road work has been put back ten years, so far as progress and efficiency are concerned, was the statement made by George Crowder, engineer and surveyor, Godstone Rural District Council, in an address before the meeting of the Institution of Municipal Engineers held at Oxted, England. Mr. Crowder suggested that the only way to improve conditions is a change in highway administration which will free roadwork from local control and put it under the national government as a means of administering a system of national highways. While insisting that the road question must always be a matter for civil governments, and not for military jurisdiction, he favored greater centralization in highway authority, and maintained that the Government Road Board should have direct jurisdiction over all trunk highways. Secondary roads which could not be considered national routes should come under county jurisdiction, while the only roads to be left with the local authorities should be the district roads. In fact, he favored a system which has been in successful operation in many parts of the United States for a number of years, and expressed the opinion that only by such a program could the after-war problems of reconstruction be met.

Thirteen-Thousand-Ton Vessel Righted by Rolling and Lifting

"St. Paul" Raised After Settling on Side in Mud Between New York Piers—Cofferdam Put On and Hull Pumped When Partly Righted—Under-Water Cutting Torch Developed

RAISING the "St. Paul," a 13,000-ton liner, which sank from an unexplained cause and turned over on its side in the mud between North River piers 60 and 61 in New York harbor early in the summer, was accomplished by using lifting pontoons and pulling tackles to roll the vessel partly upright, in which position it was then possible to place a wood cofferdam around the low side of the hull and float the vessel by pumping. After an enormous amount of under-water work, which included finding and closing a large number of openings, all buried in the mud on the low side of the vessel; the placing of wood cofferdams; the cutting of steel bulkheads to drain some compartments, and the placing of concrete bulkheads to make possible the pumping of others; the removal of a thousand tons of mud from the interior of the wreck and, after the ship had been brought to almost even keel, the distribution of sufficient ballast on the high side to right the vessel under the load of another thousand tons of mud which could not be removed, the ship was turned over to the owners, the International Mercantile Marine, on Sept. 27. She is rapidly being overhauled and refitted, and will soon be placed in service.

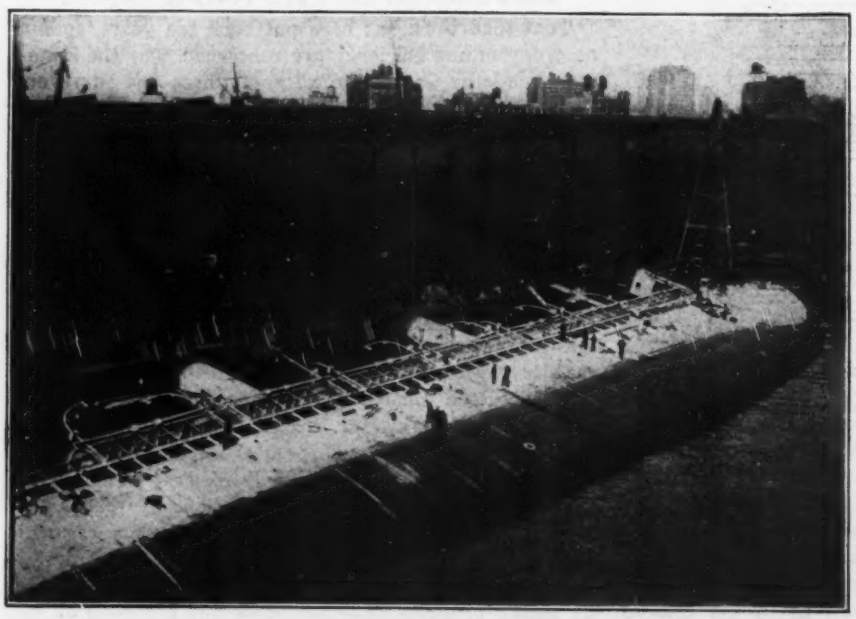
The "St. Paul" lay in the slip, bow toward the bulkhead and a little higher than the stern, port side under the mud, which came up 12 to 14 ft. on the main deck,



POSITION OF DERRICK BOATS, COFFERDAMS AND PUMPS DURING RIGHTING OF "ST. PAUL"

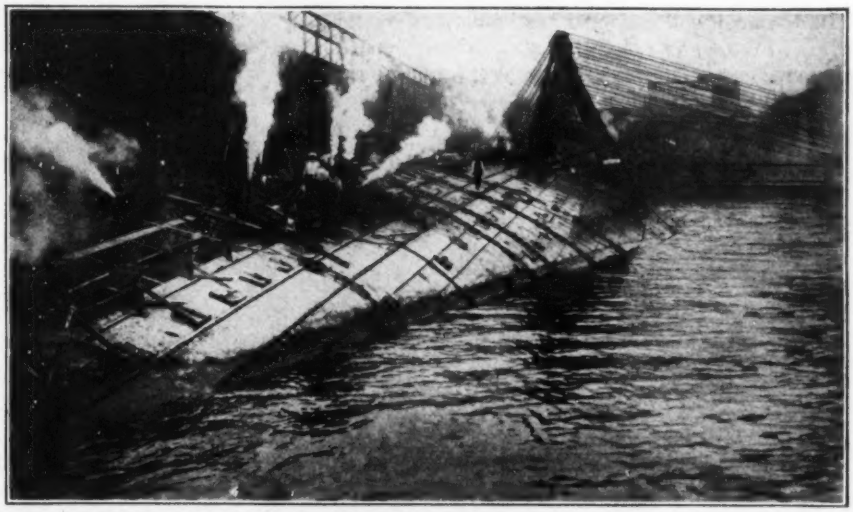
and starboard side largely exposed. She continued to settle slowly into the mud until the righting operations began. Through various openings and over the port rail about 2000 tons of mud entered the vessel.

As it was not possible at first to extend the sides of the vessel above water by cofferdamming, as is usually done, until the hull was at least partly righted, another operation had to be undertaken first. A series of 21 timber and steel A-frames was attached to the starboard side of the vessel, each frame being set over one of the ship's transverse frames and bolted to it through the plating. Only two bolts were used to secure the lower corner of each frame, where the stress was all in compression, to facilitate removal. These points came below the water line after the vessel was righted. The front leg of each frame was secured with enough bolts to take the tensile stress exerted by the tackles. Ten-part pulling tackles of ½-in. wire rope were used, each tackle being led direct to a hoist mounted on the lower



THE "ST. PAUL" ON HER SIDE THE DAY AFTER SHE TURNED OVER

deck of pier 60, downstream from the wreck. For an anchorage to pull against, these tackles were shackled to 2-in. hawsers secured to heavy U-bolts embedded in 10-ton blocks of concrete. Each of these blocks was a truncated pyramid with a lifting bolt at the top for handling, and the bolt for the pulling anchorage extending through it from side to side in line with the pull. The blocks were made on the end of pier 61, a concrete mixer being taken out on the pier and the blocks being cast within reach of one of the big derrick lighters. This lighter placed the blocks in a 25-ft. trench dredged down the middle of the slip between piers 59 and 60. A total pull of 840 tons with a leverage of 100 ft. about the keel of the "St. Paul" was obtained with this tackle.

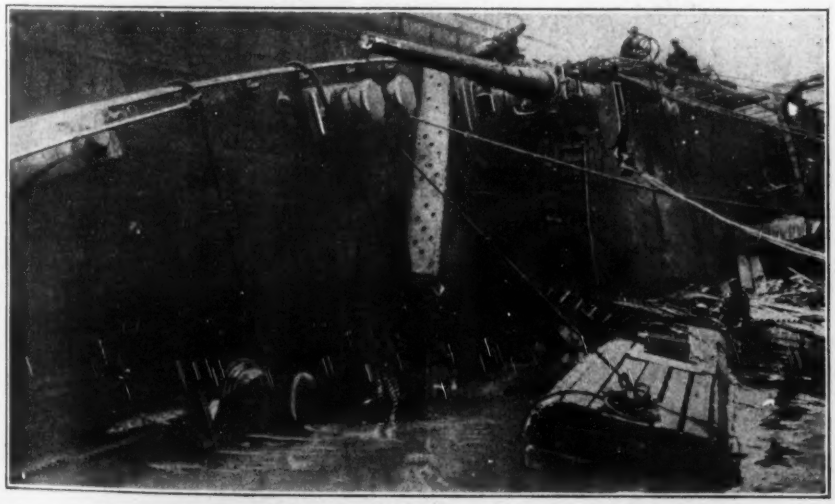


DURING THE FIRST PUMPING—A-FRAMES IN PLACE, AND TACKLES LEADING TO CONCRETE ANCHORS ON PIER 61

In addition, a direct lift of 1200 tons was obtained by using four pontoons attached to chains passed under the port side of the vessel and around the keel. To prevent the vessel from slipping downstream under the pull of the righting tackles and the lift of the pontoons, a number of steel hawsers attached to the starboard side and swept under the keel and the port side were anchored to the substructure of pier 61.

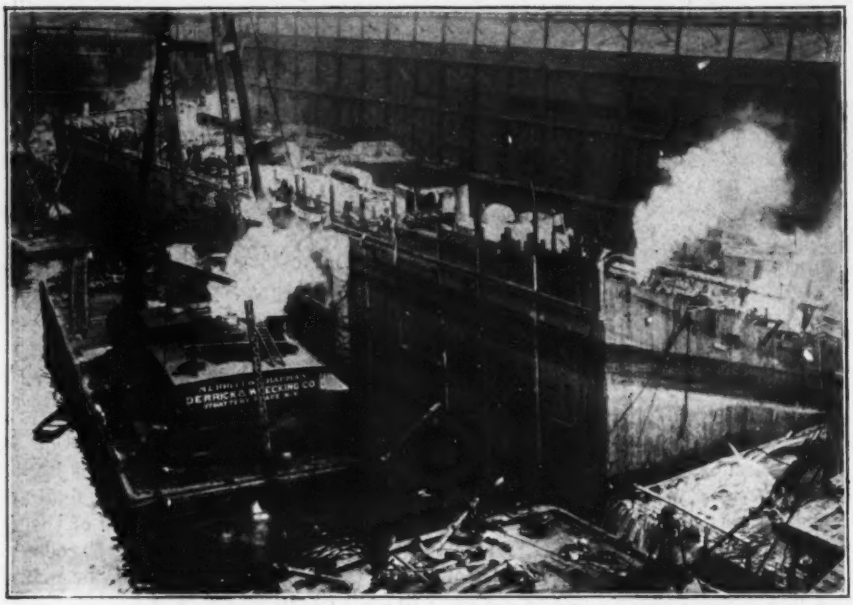
Before these cables and the chains from the pontoons could be swept under the hull, it was necessary to dredge down under the lower side along the deck and also along the keel. This dredging also helped the divers to get mud out of the hull and also to get at the port holes and close them. By anyone familiar with the internal architecture of an ocean liner, with its closely-spaced decks, its numerous bulkheads and partitions, its winding passageways, and narrow and steep stairways in the machinery and cargo compartments, the difficulty of a man in a diving suit making his way through this labyrinth, lying on its side, in muddy water, and finding and closing a large number of port holes (many of them 10 ft. under the mud) can be appreciated. Excellent time was made with this work by having one or more divers assigned to each compartment, and letting them work there until everything was finished. These men, after having made careful surveys of their compartments under water and having compared with the ship's plans what they found, became familiar with their surroundings and worked to much better advantage.

A large ash port was closed with a double plate made above water. The divers first took down a thin lead sheet, and, using a hammer, made a perfect templet of the opening and the bolt holes surrounding. A ½-in. plate was then cut and drilled to fit this templet and then was placed by a diver. The entire patch did not leak a drop during the raising of the vessel. A number of holes were cut in the bulkheads under water to drain some of the compartments into others for pumping. At first this work was done by dynamite, but before more than a few plates had been removed in this way a successful under-water oxy-acetylene torch was perfected. This torch lights at will and cuts almost a foot a minute in ½-in. plate, at depths up to 54 ft., which was the greatest depth at which it was necessary to cut. A covered lighter was in the head of the slip at the time of the sinking, and lay in such a position that it could not be removed. It was fitted up as a small machine and repair shop and used throughout the work.



MUCH WORK FOR DIVERS TO CLEAR WAY TO START CLOSING UP SHIP
A 6-in. gun similar to the one shown had to be removed from the under-water side

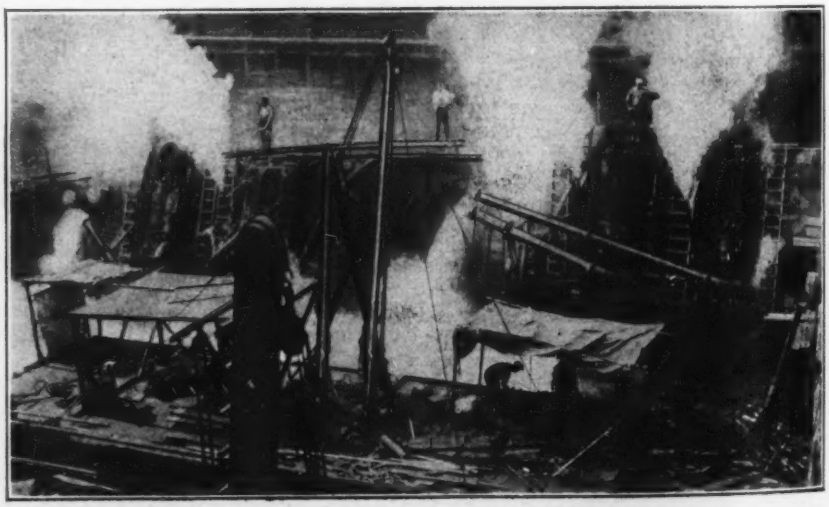
Of the mud which entered the lower part of the ship or lay in the alleyways on the port side on decks 1 and 2, as much as possible was removed before the first rolling operations. A second effort was made to remove mud before the next phase of the work was undertaken, but even after the vessel was floated it was found that approximately 1000 tons of mud was left in the port side of the ship.



COFFERDAM ALONG PORT SIDE—DECK 1 AT BOW AND STERN JUST OUT

In the first rolling of the vessel, it was decided to pump the forward and aft ends, the pilot house, the captain's and officers' rooms forward, and the smoking room at the after end of the ship. Rolling was started on July 22, during which day the vessel was brought up to within 36 deg. of being on an even keel. Subsequently, a gain of little less than 2 deg. a day was made until the rolling operations were suspended, on the night of July 28. The pontoons were then taken off and work was begun on closing up the entire vessel. A part of the cofferdam work consisted of placing two large mass concrete bulkheads and several smaller ones. One of these closed a companionway on the port side of the vessel and the other closed three hatches on deck 2. The concrete, which was mixed with small stone by hand above water, was shoveled into a hopper and carried to the forms through the water in a 1½-in. flexible hose. With each bulkhead a back form was built complete, and a form on the face was carried up by the divers as filling progressed. The closure at the top in each case was calked after the concrete had set, although it is doubtful if this was necessary. Very dense, hard concrete, which was difficult to remove, resulted.

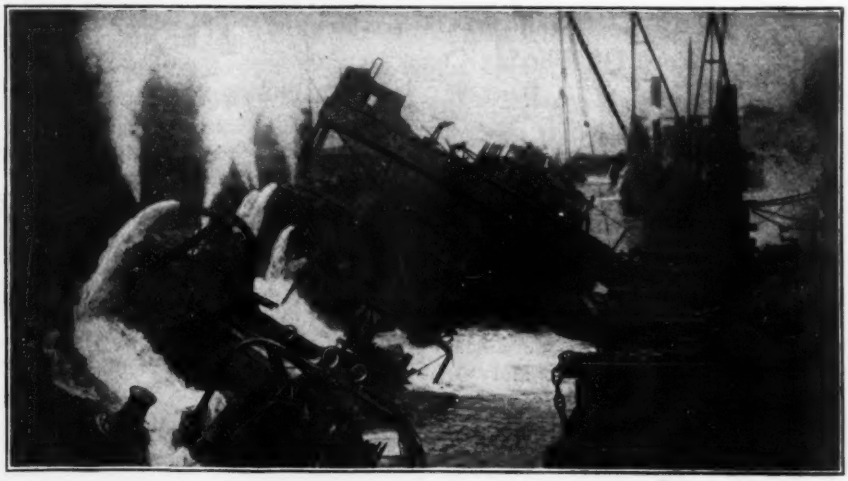
The rest of the cofferdam work was of wood. It extended around hatches 2 and 3 and along the port side from forward of the bridge to 6 ft. aft of the aft end of the engine room. This cofferdam was made of 3-in. tongue-and-groove planking, framed dry in sections, lowered under water and secured to the steel rail on the main deck with hook bolts. With this in place it was possible to pump the ship and roll it at the same time. The A-frames were used, and the derricks "Monarch" and "Commander," lifting on the chains which had been attached to the pontoons used in the first operation. By this means the vessel was brought up to a 13-deg. list, when the A-frames were removed from the starboard side. About 600 tons of rock ballast was next put into the ship, 250 tons being placed in hatch No. 4 by a chute, so that it lay from amidships as far toward the starboard side as possible, 100 tons being put in hatch No. 2 in the same way and 250 tons being placed through a coal chute, reinforced for this work, in the forward coal bunker on the starboard side. After the ballast was placed in the vessel divers were used to trim the ship by moving the ballast as far to the starboard side as possible.



PUMPS HAD TO BE AWKWARDLY PLACED, OPERATORS WORKING FROM LADDERS

The third stage of the work consisted in pumping the entire ship, steadying it by the derricks "Monarch" and "Commonwealth" on the port side and the derricks "Commander" and "Chief" on the starboard side. The

vessel first righted up to about 4 deg. from vertical, and floated forward and aft approximately five hours after the pumps started. This was accomplished Sept. 11. As everything movable within the vessel had fallen over to the port side, she continued to list from 3 to 5 deg. during the remainder of the pumping operations. These continued for two weeks, during which time the vessel floated higher and higher as weight and sections of cofferdam were removed from the upper part of the ship and mud and wreckage from the port side, starting on the upper deck and gradually working down to deck 2, deck 3 and deck 4.



PONTOONS AND A-FRAMES PULLING SHIP FROM 73-DEGREE TO 27-DEGREE LIST

When it was seen that the vessel would still hold a definite list to port, 305 tons of additional ballast was put in hatches 1 and 2. Twenty-five tons of chain and 280 tons of slag were used.

On Aug. 28 a force of workmen was placed on the ship for cleaning and renewing the winches, ventilators, the ship's windlass and other parts of the ship's machinery, and on Sept. 12 a much larger force was put to work repairing and cleaning the ship and putting its machinery in running order. On Sept. 27 representatives of the International Mercantile Marine formally took over the vessel.

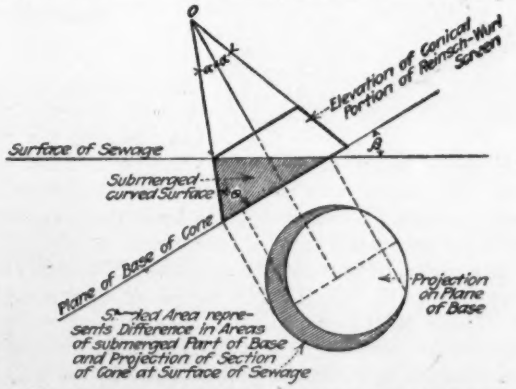
SMOKESTACKS AND MASTS OF THE "ST. PAUL" HAD TO BE BLASTED OFF

The work of raising the "St. Paul" from the mud was carried out by the Merritt & Chapman Derrick & Wrecking Co., under the immediate direction of Capt. J. M. Tooker, superintendent, and Ralph E. Chapman, salvage engineer.

Finding Submerged Curved Area of Reinsch-Wurl Screen

By Frank S. Bailey
Assistant Engineer, Metcalf & Eddy, Boston, Mass.

IN ORDER to make comparisons of the efficiency of different types of sewage screens, it is necessary to know the area of the portion of the screen which is submerged in sewage. This area can be easily found in most cases, but the Reinsch-Wurl screen, a part of which sometimes consists of a frustum of a cone set at an angle with the surface of the sewage, presents some difficulties. A simple method of determining the area of the curved surface of the submerged portion of the cone has been found which gives exact results and which can be applied about as easily as an approximate method.


Elevation of Conical Portion of Reinsch-Wurl Screen
Surface of Sewage
Submerged curved Surface
Plane of Base of Cone
Projection on Plane of Base
Shaded Area represents Difference in Areas of submerged Part of Base and Projection of Section of Cone at Surface of Sewage

SUBMERGED AREA OF CURVED SURFACE OF REINSCH-WURL SCREEN IS EASILY FOUND

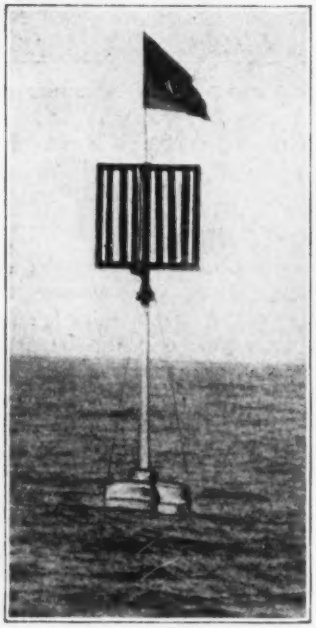
A section through the cone at the surface of the sewage is a segment of an ellipse. To find the submerged area, determine the area of the projection of this segment on the plane of the base of the cone (see sketch), subtract this area from the area of the submerged portion of the base, and multiply the difference by the secant of θ, or what is the same thing, divide the difference by the sine of α; the result represents the area of the submerged curved surface of the side of the cone.

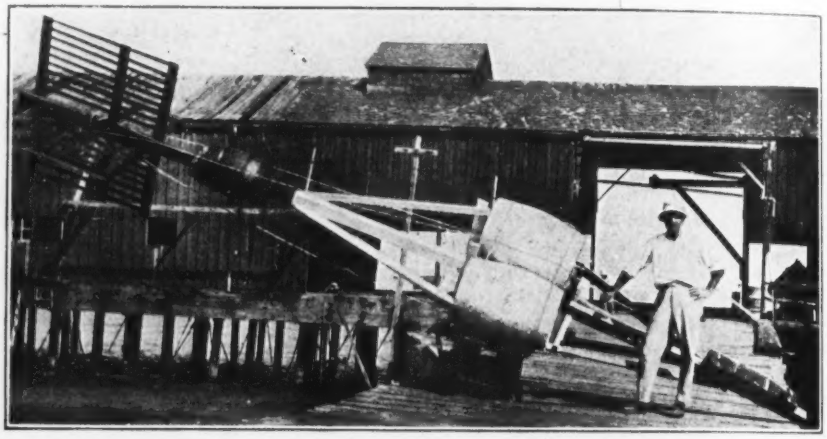
Floating Target Facilitates Wire-Drag Work Off Florida Coast

By J. H. Hawley
Hydrographic and Geodetic Engineer, United States Coast and Geodetic Survey, Washington, D. C.

FLOATING signals of the type shown in the accompanying photographs were used last summer on wire-drag work in the vicinity of the westerly Florida reefs, where practically all of the work was out of sight of land, and the only triangulation signals available were three lighthouses and a tall hydrographic signal erected on a small sand key.

The floating signal consists of a heavy center pole with a target at the top and a counterweight at the bottom, supported, at a point about two-thirds of its length down, by three barrels securely lashed and braced, the mooring chain being attached to a bridle at the water line. The signal was quickly and cheaply constructed, and was durable, and sufficiently large to be visible for miles; it was easily handled from small vessels.





FLOATING TARGET PROVES CHEAP, DURABLE, EASILY HANDLED AND VISIBLE FOR MILES

In a period of four months an area of 232 square miles was examined. It is the first wire-drag work ever done in Florida in the summer season, and the decrease in unfavorable weather as compared with the winter season resulted in a considerable decrease in the unit cost of the work. It is also the first wire-drag work ever done out of sight of land, in open and entirely exposed waters.

Imperial Valley All-American Canal Progress

Last summer much enthusiam was expressed in the Southwest over the possibilities of an all-American canal to the Imperial Valley in California, and the engineers of the United States Reclamation Service were ordered to investigate. W. H. Schlecht, project manager, Yuma Project, reports in the September *Reclamation Record* that trial lines, including topography, have been finished, and that work on test pits, estimates and additional topography at the west end of Laguna Dam is under way.

Traveler Handles Forms and Steel for Ore Dock

Timber Structure Spanning Site Gives 60 x 90-Foot Clearance—Concrete Spouted Into Place By Floating Plants

IN THE construction of a concrete ore dock at Ashland, Wis., the forms and reinforcing steel were handled by a large timber traveler of the type employed in the erection of steel truss bridges. This traveler, which spanned the structure, as shown in the accompanying view, was carried on a pair of sills 40 ft. long, mounted on grooved wheels on two rails forming a track of 62 ft. 8-in. gage. It had a clearance of 90 ft. in height above the rails and 60 ft. in width between the plumb posts. The top consisted of two trusses 14 ft. apart and 14 ft. deep, giving a total over-all height of 104 ft. The full load was six tons on each of the four hoisting lines.

Each sill consisted of two 8 x 8-in. timbers 40 ft. long, spaced 2 ft. on centers and trussed with two 1¼-in. rods. These carried the platforms on which the hoisting and propelling engines were mounted. Under each sill were two trucks, each with a pair of grooved wheels spaced 4 ft. on centers. The two sides or towers were built of four 8 x 8-in. spliced posts 86 ft. long, with 1⅛-in. rods and 6 x 8-in. braces seated on cast-iron brace blocks. The towers were 14 ft. square at the top and carried the two trusses, which had five panels of 12 ft. 4 in. These trusses were built of 8 x 12-in. and 8 x 8-in. timbers and 1¼- to 1½-in. steel rods.

Timber forms for the superstructure consisted of heavy trusses 60 ft. long, built in three sections. These were quickly set up by the traveler and seated on wedges placed on transverse 14 x 14-in. timbers which passed through the 3 x 10-ft. concrete columns, thus making it unnecessary to use supporting falsework. Forms for the ore pockets were built up of heavy skeleton trusses filled in with small sections of panel forms which were placed by hand. These panels were moved up as the concreting progressed, so that the steel reinforcement was accessible at all times in advance of the concrete.

The trusses for the pockets had each a collapsible side, which permitted their being withdrawn in pairs by the traveler and carried to the next position.

Concreting was done by two floating plants, each mounted on a 34 x 110-ft. scow, 10 ft. deep. Upon the scow was a ¾-yd. mixer serving a 1-yd. elevator bucket in a timber tower 120 ft. high. The boom and chute could be adjusted to any desired height on the tower. Gravel and sand were delivered at a dock by large derrick scows, and transferred to bins or hoppers on the concreting plant by smaller derrick scows using 1-yd. clamshell buckets. Cement was unloaded from cars at a storage house and transferred to the sheds at the mixers by a derrick scow. For moving, the mixer plants were equipped with hoisting engines operating two cables.

This reinforced-concrete ore dock was built for the Minneapolis, St. Paul & Sault Ste. Marie Ry. in 1916-17. It is 1132 ft. long, with its deck 80 ft. above the water level. Its design was described in *Engineering News* of Aug. 10, 1916, p. 243, by W. E. King, of the Toltz Engineering Co., St. Paul. The work was done under the direction of C. N. Kalk and E. A. Whitman, successively chief engineers of the railway. The general contractors were Foley Brothers, St. Paul, Minn.

City Has Much Land Under Lease

Scattered along its aqueduct and in the drainage area from which the aqueduct draws, the City of Los Angeles owns nearly 77,000 acres of land acquired for water and power project purposes. The lands are leased under charge of John T. Martin, land department, Department of Public Service. For small tracts full cash in advance payment is required.

Montezuma Aqueduct on Erie Canal Is Demolished

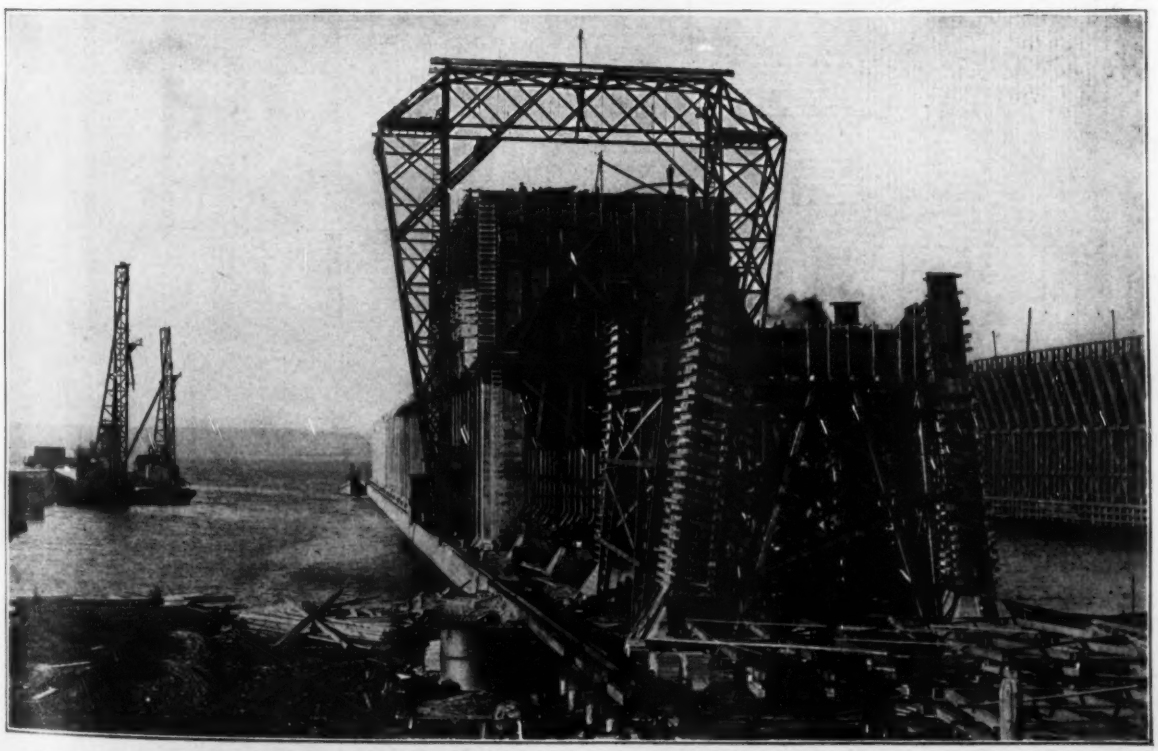
Masonry Arches and Timber Flume Started 69 Years Ago Were Last Impediment to Opening of New York Barge Canal

By J. G. Palmer
Assistant Engineer, Department of State Engineer and Surveyor, Port Byron, N. Y.

MONTEZUMA aqueduct, perhaps the most notable structure on the old Erie Canal, was removed this year to provide clearance for the New York State Barge Canal, which lies in the bed of the Seneca River crossed by the aqueduct. A masonry and timber structure nearly 70 years old, its condition after years of service, and the method of its demolition, all have engineering interest.

The aqueduct, located in the Montezuma marshes a mile west of the village of Montezuma, N. Y., and ½ mile below the junction of the Seneca and Clyde Rivers, was built during the first enlargement of the Erie Canal. The first contract for its construction was dated Sept. 27, 1849, but, because of the failure of the contractor after most of the foundations and about half of the masonry had been completed, a second contract was let on July 15, 1854. The structure was completed and placed in service in the spring of 1856, at a cost of $216,510. Some of the data used in this article were taken from the final estimates for these contracts.

The aqueduct consisted of a wooden flume which carried the canal, and a series of stone arches along the downstream side of the flume, which arches carried the towpath. Both the flume and the arches spanned the openings between the masonry piers. The flume was



TIMBER TRAVELER HANDLES FORMS AND REINFORCING FOR ORE DOCK—FLOATING PLANTS PLACE CONCRETE

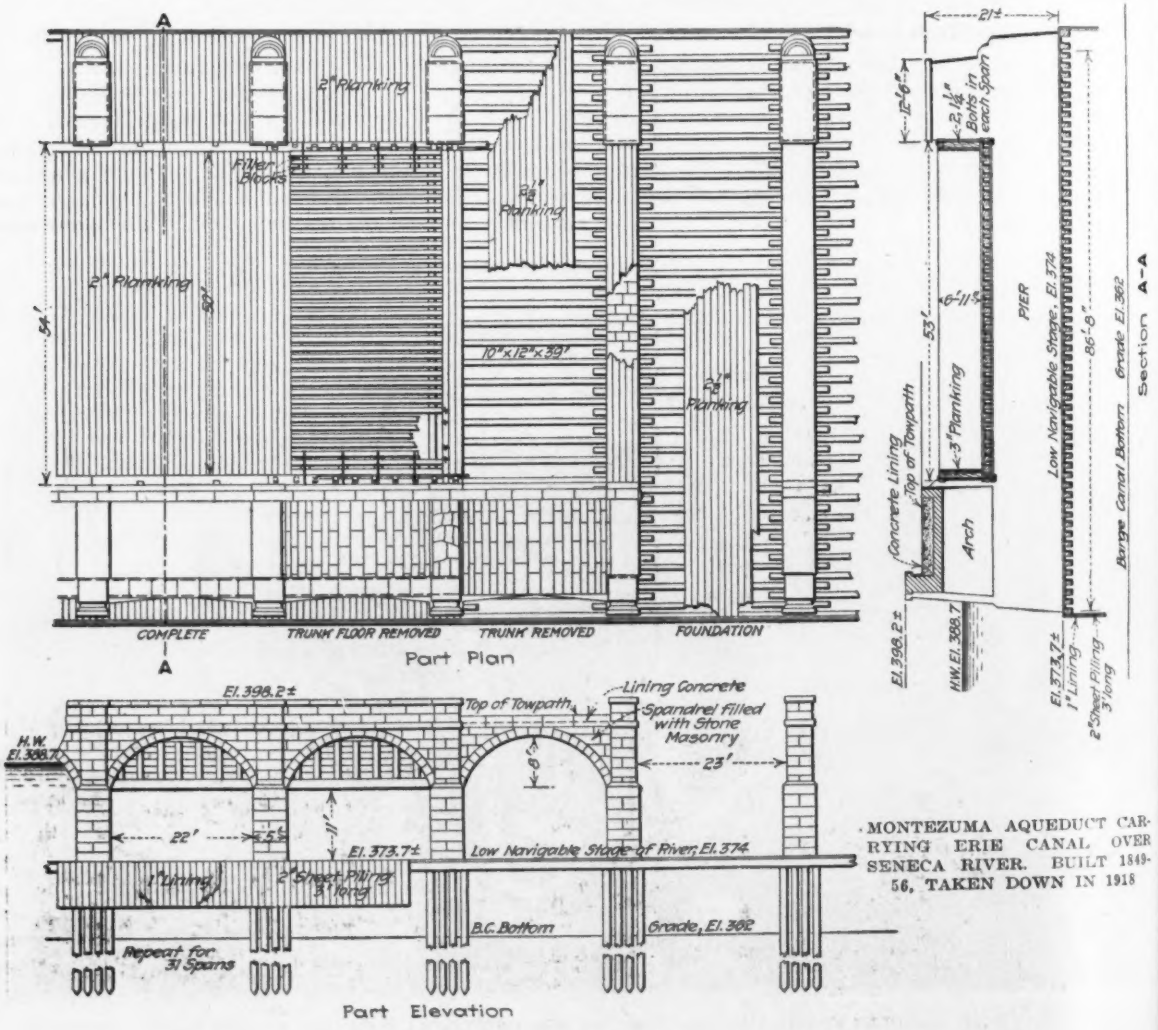
about 840 ft. long, 50 ft. wide and 7 ft. deep. The towpath was 13½ ft. wide. The piers were 90 ft. long by 5 ft. wide, and their ends extended above the flume to support its sides against the horizontal pressure of the

LOOKING TOWARD MONTEZUMA AQUEDUCT SECTION

arches were filled with dimension stone masonry, continuous over the piers. This masonry was covered with a 6-in. layer of concrete and a 12-in. layer of gravel which formed the towpath.

The masonry was Onondaga blue limestone laid in "hydraulic lime" mortar. The soffits and the copings were bush-hammered, and the remainder was quarry-faced ashlar in courses which varied from 1 to 2 ft. thick. The copings were doweled with iron rods set in melted lead. This masonry was found in excellent condition, unweathered, free from cavities and not greatly in need of repointing, although the mortar was weak.

A pile and grillage foundation supported the structure. The grillage timbers or caps extended from pier to pier and were covered with plank laid close which formed the bottom of the river and the base for the piers. The grillage was protected from underscour by a line of double-lap sheet-piling and riprap along both sides, which has been effective, although the sheet-piling was only 3 or 4 ft. long. The cap timbers were 40 ft. long, 10 in. thick, vertically, and in some cases, 12 in. wide, while others were tapered in the latter dimension. The fact that they were hewed accounts for this variation. No other hewed timber was found in the structure. There were four rows of piles under each pier, with 30 piles in a row. The piles were staggered so that each cap rested on two piles in each pier. The caps were fastened to the piles with wooden pins, and the planks were fastened with square, tapered pins.

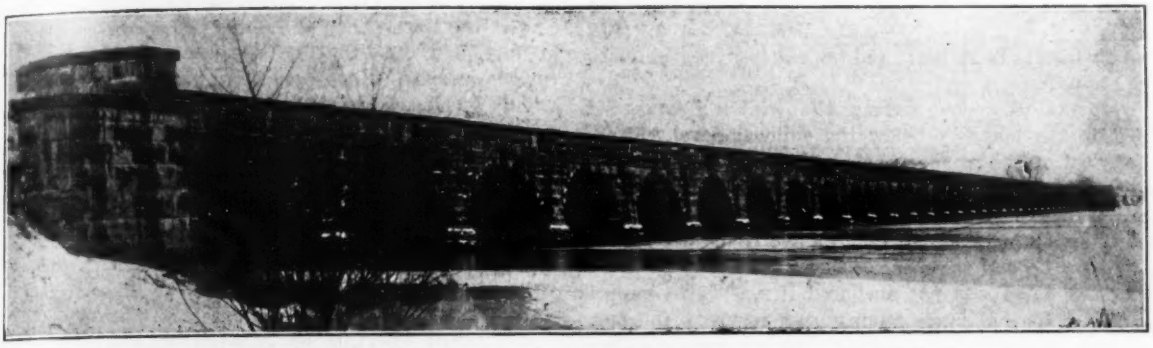


MONTEZUMA AQUEDUCT CARRYING ERIE CANAL OVER SENECA RIVER. BUILT 1849-56, TAKEN DOWN IN 1918

Between the piers there were short piles under the outside caps "to support the sheet-piling," as stated in the estimates.

The foundations were well preserved, with the exception that the plank were somewhat water-worn, having been reduced in places from 2½ in. to 1½ in. thick.

Since the current through the aqueduct was accelerated by the lowering of the water that accompanied the completion of the prism of the Barge Canal, it was considered unsafe to excavate near the structure until it was time to abandon the Erie Canal. For this reason, in 1911 a bulkhead of triple-lap sheet-piling was

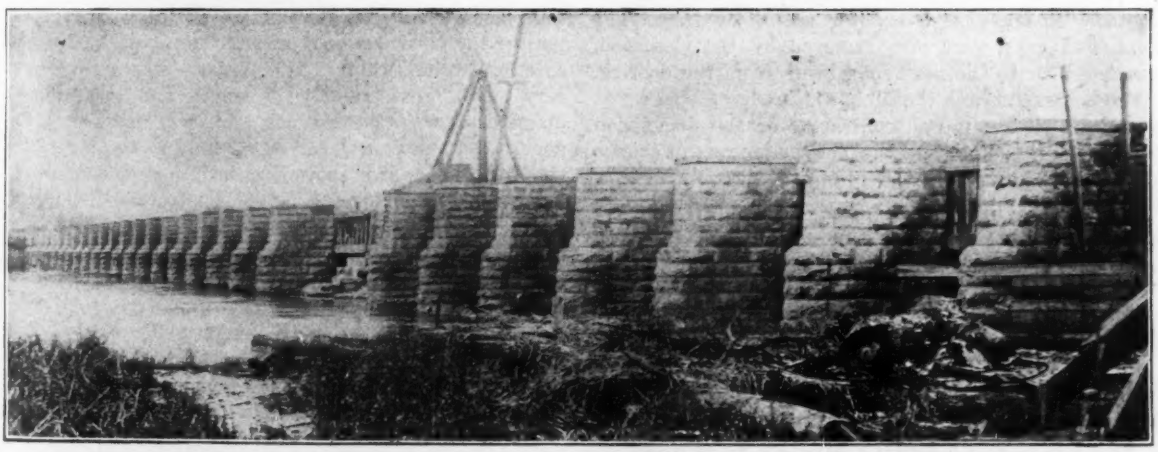


TOWPATH ARCH SIDE OF THE AQUEDUCT CARRYING ERIE CANAL OVER SENECA RIVER

The piles were mostly soft wood, ranging from 8 to 12 in. in diameter and from 7 to 35 ft. long, though the estimates show that some of them had been spliced to a length of 56 ft. They had been cut off to grade with axes. The load was about 7 tons per pile. The crushing stress on the caps, across the grain, was as high as 280 lb. per square inch, and, although they were hemlock, there was very little evidence of crushing.

Although it has been renewed more than once, the flume was found to agree closely with the original plan, except that there were more floor stringers than are shown. The stringers were yellow pine, the side frames were oak, and the lining was white pine, match planed to tight joints. It was 3 in. thick on the sides and 2 in. thick on the bottom of the flume. The sides were decayed and very leaky. The floor was sound and tight. The newest stringers, which were about 13 years old, were sound, and the oldest spans contained many sound ones. The sides of the flume were at the canal water level, forming a spillway, and there were 15 drainage gates, about 2 ft. square, in the downstream side of the flume, the bottoms of which were at the level of the floor.

placed across the bottom of the river, 800 ft. below the aqueduct. Excavation was stopped at this point and 400 ft. above the structure. Preparatory to the opening of the Barge Canal last spring a contract was let for completing the prism, removing the bulkhead and 20 spans of the aqueduct, and other work in the vicinity. The contractor assembled his plant, for the demolition, by boat on the Erie Canal, placing it on the banks at the ends of the aqueduct, and moved it into position as soon as the canal was drained. A hy-



CANAL WAS CARRIED ON TIMBER FLUME SPANNING BETWEEN MASONRY PIERS

draulic dredge was brought up the river and excavated in the prism during the month of December. With the exception of a short time during the spring flood, work on the aqueduct progressed continuously until it was completed in July, 1918. This was remarkable, considering the exposed location and the unusual severity of the winter.

In the spring a dipper dredge was brought on the work, which removed the pile foundations and some hardpan that was in the vicinity. This material was either cast over or hauled by scows and dumped in the prism, where it could be disposed of by the hydraulic dredge. The plant for the demolition consisted of a

traveling derrick on the bottom of the flume, a narrow-gage locomotive and two side-dump cars on the towpath, a compressor, an air drill, two skips and a clamshell bucket. The derrick and the train removed everything above the foundation piles, finishing one span at a time and moving toward the dump, which was at the west end of the aqueduct. The stone, pine and hemlock were dumped over the back of the towpath bank, which is 14 ft. high, and the oak was burned under the compressor boiler.

Progress was slow during the winter because of frost in the masonry below the spillway level. Practically all of the masonry below this level was blasted, while very little blasting was done after the frost was out. Only two spans were removed in any winter month, but this was increased to four or five spans per month in the spring and summer.

As the flume was not anchored it was easily pulled apart. A span of flume having been removed, the pier and arch were attacked together. Several methods were tried on the arches, but the following was finally adopted: A timber platform, supported on the masonry and on posts, was placed under the arch. The spandrel filling having been removed from the half that was further from the derrick, the key was taken out, racking back to the springing line. In this way the half arch stood until the last keystone was removed; the other half with its spandrel filling remained standing until it was taken down. None of the piers showed a tendency to overturn after the removal of an arch from one side. The stone that was under water was removed by the clamshell after having been drilled and blasted. In one case the water was 6 ft. deep. The plank and caps were also removed by the clamshell, reaching over to the next span away from the derrick.

The contractor was the Mohawk Dredge & Dock Co., Herkimer, N. Y.; the subcontractor on the demolition was Scott Bros., Rome, N. Y. The writer was in charge for the state and F. J. Beach, junior assistant engineer, was in local charge.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Three-Stage Concrete Mixing in Single-Barrel Mixer

Sir—I am very much interested in Frank B. Walker's letter in *Engineering News-Record* of Sept. 26, 1918, p. 595. It would not be necessary to use the "three-stage mixer" referred to by Mr. Walker to obtain the results he desires. I obtained these results for a number of years by mixing concrete in an ordinary mixer, by the following method:

First, place in the mixer the required amount of water; next, add the required amount of cement (which makes the cement "solution" referred to by Mr. Walker); then add the coarse aggregate, which becomes thoroughly coated by the cement "solution"; last, add the fine aggregate; and the result will be obtained.

The above description is for concrete mixed in a one-bag batch mixer from a loading platform. However, should a large mixer be used the loading side should be equipped as follows: Water tank; cement hopper; coarse-aggregate hopper; fine-aggregate hopper.

The concrete could then be mixed in the proper manner, using a minimum amount of water, by first putting in the water, then the cement, then the coarse aggregate, and then the fine aggregate, by opening the various measuring hoppers in the rotation mentioned.

This has been demonstrated in the manufacture of reinforced-concrete pressure pipes, on a number of large contracts, which are working successfully under internal hydrostatic pressures up to 45 lb. per square inch, the concrete being water-tight.

COLEMAN MERIWETHER,
Manager, Cement Products Bureau, Portland Cement Association.
Chicago.

Wood Borers in Southern Waters

Sir—The correspondent writing in *Engineering News-Record* of Sept. 19 on "Marine Wood Borers Work in Deep Water" seems to have a misapprehension of the habits of certain of these destructive pests. The borings shown in the reproduction of a photograph in the lower view on p. 551 certainly were not made by limnoria. Apparently they are the work of the teredo; probably that of the very common teredo navalis.

Limnoria inhabit the surface of a pile on a zone coinciding approximately with the tidal range, wherein they make holes ranging in diameter from that of a common pin head to that of the pin point. Their borings being visible on the surface of the wood, the extent of their ravages may usually be ascertained by inspection at low water. The teredo enter a pile when very small, grow rapidly in length and increase the diameter of their bores up to ½ in. or ¾ in. They seem generally to enter as near as possible to the mud line; the first foot or two above that level may be completely honeycombed, while at a height of 4 or 5 ft. but few can be found. For this reason the services of a submarine diver are usually required for the inspection of teredo-infested piles in place. The entrances being so small, and the animals never emerging from their self-made prisons, the pile may appear to be sound, while in reality it is only a thin shell covering a honeycombed interior. When a teredo-weakened pile breaks it will almost certainly break just above the mud line.

The bores of the teredo are always lined with shell, wherefore calcareous shores of warm seas are especially favorable for the rapid growth and propagation of this pest. Certain species of wood, especially hardwoods, resist the teredo better than others, but it is believed that none is wholly immune from their attacks. A timber structure built in waters where none had existed previously may have quite a long life, because a considerable time may elapse before the borers discover and colonize it in large numbers; but where untreated wood piles are driven in a locality known to be already badly infested they cannot be expected to last long. It is more than probable that, in the Cuban case mentioned, the same sort of pile used for repairing a pier that has failed will last much less than the five-year life of the original piles.

While on this subject it may be well to direct attention to an important point not generally appreciated, namely, the necessity of preserving absolutely intact the continuity of the protective coats of wooden piles protected by any process. Just as a pin prick in the human hand may permit a fatal infection to enter, so may a split, axe cut, pike pole or chain-dog puncture of the armor permit the entrance of the borers, which will proceed to consume the interior, leaving the protective coat standing as a hollow shell.

Oakland, Cal. EDWARD M. BOGGS.

Sir: Referring to Mr. Hobby's letter on marine borers, I would say that we have had a similar experience here, but with creosoted instead of native hardwood piles. I have in mind especially some 12-lb. treatment shortleaf pine piles driven in 1912 in 42 ft. of water. Late in 1917, about 5½ years after driving, these piles were eaten completely off at the mud line. We have very little trouble here with piles being eaten at the water line; they go much more quickly at the mud line.

There are, I believe, three varieties of worm working on the piling here: a species of limnoria working near the water line, which takes 12 or 14 years to ruin a native hardwood pile; the teredo, which works from the water level down, and another kind of worm which works at or near the mud line.

This mud-line worm seems to do more damage in comparatively deep, clear water than where the water is shallow or fouled with sewage, etc. I think one reason for its working near the mud line is the presence of less marine growth on the pile at that point.

The pictures in Mr. Hobby's article are very typical of the action of this worm.

The life of a creosoted pile in deep, clean water in Cuban bays cannot be safely figured at more than seven or eight years. CHARLES H. JOHNSON,

Foreman Public Works Department.

Guantanamo Bay, Cuba.

Tests of Flow in Brick-Lined Water Tunnels in Chicago

Sir—Referring to your article in *Engineering News-Record* of Sept. 5, p. 445, entitled "Flow in Chicago Water Tunnels is Tested by Salt Solution Method," the writer believes it may interest your readers to know that, shortly after the completion of these tunnels, he made very elaborate experiments to determine the elements of flow in these tunnels. The results of these experiments and calculations, which covered a considerable period of time, were published in the *Journal* of the Western Society of Engineers, Chicago, Vol. XVI, October, 1911.

A brief comparison of the average results then obtained, and those later obtained by salt-water tests in 1917, is given in the accompanying table. It should be noted that at the time of the first experiments the capacity of the stations had not been fully developed. Therefore, the velocities of water in the tunnels were considerably less than at the time of the later experiments, when additional pumping machinery had been installed.

It is also to be noted that the divisions of the 10-ft. tunnel for experimental purposes were different during the two sets of tests, in that the intermediate observation points were at different places. The short piece of 10-ft. tunnel from Kingsbury St. to Green St. in the first test was especially well constructed, and this short piece of tunnel in which more favorable results were obtained would not influence the general average when compared with the results on the longer stretches.

In the section from Carroll Ave. to Central Park Ave., in the first test (which forms a part of the section from Green St. to Central Park Ave. in the second test), there is a stretch of 850 ft. where the diameter had been reduced from 8 ft. to 7 ft. 2 in. by the introduction of an extra ring of brick. This was not taken account of in the second test. JOHN ERICSON,

Chicago, Ill. City Engineer.

[Mr. Ericson's paper in the *Journal* of the Western Society of Engineers is nearly 50 pages in length, including discussion, and is accompanied by numerous diagrams and other illustrations.—Editor.]

Counties Maintain Nebraska Roads

Highway maintenance in Nebraska is taken care of by the county authorities, their work on state-aid roads being subject to the approval of the state highway department. Each county is required to lay out all main roads connecting towns, not to exceed 20% of its total mileage, as county roads. In maintenance work, the state-aid roads come first and then the county roads, the balance of funds available being spent on the less important roads. The county engineer makes inspections at regular intervals and orders such repairs as may be necessary. Earth roads are taken care of by districts, each having from three to six miles. Hard-surface roads in Nebraska are practically all paved with brick. George E. Johnson is state engineer.

COMPARATIVE RESULTS OF TESTS OF FLOW IN THE NORTHWEST LAKE AND LAND TUNNELS, CHICAGO

Average Results of Four Gagings by John Ericson, 1902 and 1903

Section	Diameter of Tunnel, Ft.	Length of Section, Ft.	Ave. Vel., Ft. per Sec.	Ave. Slope per 1000 Ft. (1000 S.)	Ave. Factor "C"	Ave. Factor "n" (by Formula)
Crib to Kingsbury St.	10	20,483	2.123	0.1288	118.6	0.0145
Kingsbury to Green St.	10	2,216	2.123	0.1108	127.2	0.0135
Green to Keith St.	8	3,328	1.470	0.1060	105.5	0.0155
Keith to Springfield Ave.	8	18,855	*1.373	0.0822	109.1	0.0149
Green to Carroll Ave.	8	2,759	1.814	0.1140	119.6	0.0138
Carroll to Central Park Ave.	7' 2"	850	2.200	0.1152	119.2	0.0138
	8	16,647	1.814			

* Three gagings only in this case.

Average Results of Three Salt-Solution Tests, 191

Section	Diameter of Tunnel, Ft.	Length of Section, Ft.	Ave. Vel., Ft. per Sec.	Ave. Slope per 1000 Ft. (1000 S.)	Ave. Factor "C"	Ave. Factor "n" (by Formula)
Crib to Chicago Ave. June.	10	14,033	3.559	0.333	123.1	0.0142
Chicago Ave. June. to Green	10	8,666	3.145	0.279	122.4	0.0144
Green to Springfield Ave.	8	22,183	2.327	0.203	115.6	0.0144
Green to Central Park Ave.	8	19,856	2.583	0.240	118.5	0.0141

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

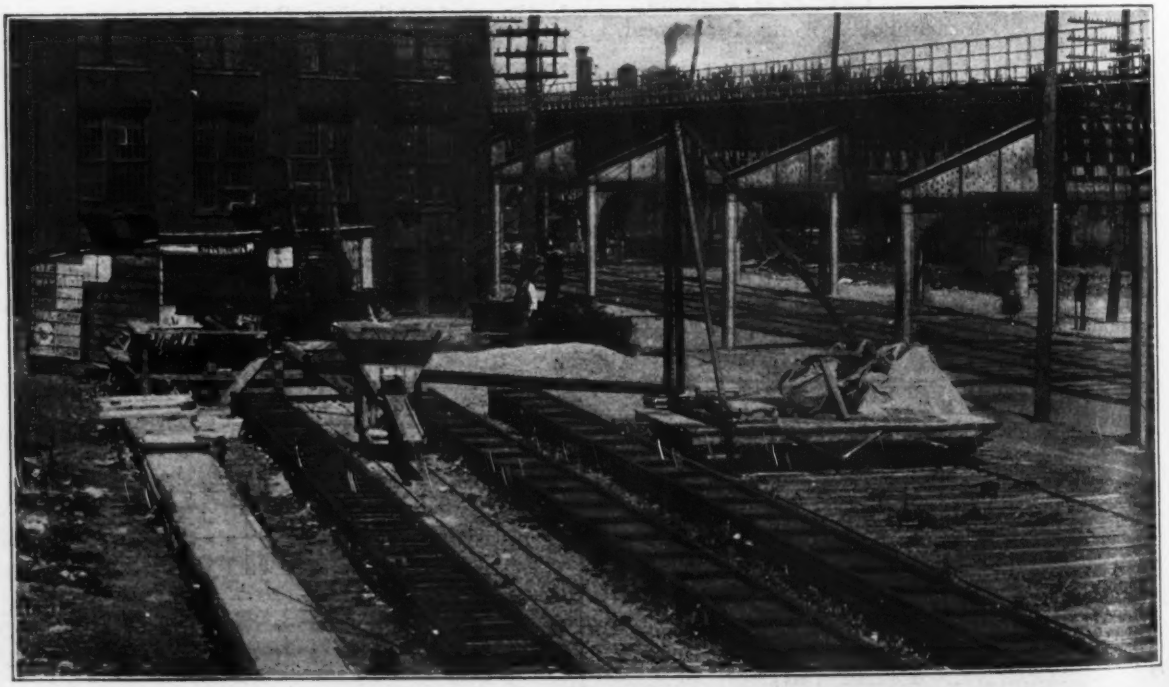
Traveling Spouting Hopper and Derrick Minimize Work in Slab-Casting Yard

CASTING 10,000 pieces, embracing 120,900 sq.ft. of rod-reinforced-concrete walkway slabs for the Frankford elevated line in Philadelphia, was looked upon by George B. Klopp, subcontractor for the Keystone State Construction Co., as enough of a job to require a carefully worked out plant. Availing himself of a vacant lot nearly a block long on the west side of the structure, near the center of the line, he laid out four lines of casting platforms long enough to accommodate in all 320 5-ft. 3-in. slabs. In the center is a traveling hopper on a light track, which is filled by the ½-yd. mixer at one end of the yard and is able to spout concrete to any of the platforms. On the east side, mounted on light rails, is a small traveler derrick which handles and stacks the slabs after the forms have been removed. The mixer is charged by hand with sand and gravel delivered by truck. The traveling hopper holds a little more than a yard, and as each slab contains about 1¾ cu.ft., a good many can be poured from one loading.

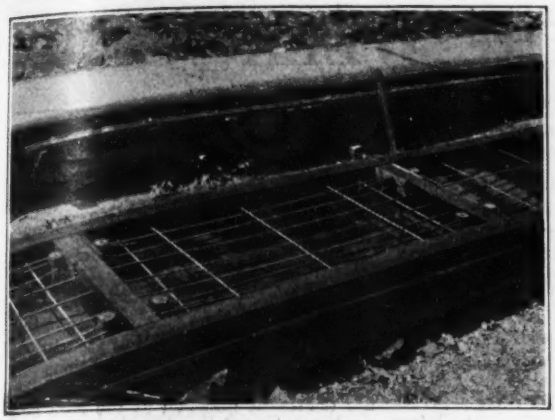
The forms are low platforms of 1-in. plank, on top of which sheet iron is placed. At the edges of the sheet iron are screwed 3 x 4-in. strips, the blocks being separated by 2-ft. strips of the same size fastened with a pair of screws. When the blocks are finished they can be readily removed by taking out the screws and lifting off the strips. The slabs are reinforced with ⅜-in. rods both ways, and at each of the four corners is a cast-iron socket for bolting them to the elevated structure. The cast-iron sockets and the reinforcing rods are set and enough forms prepared for pouring 60 to 80 of the blocks in one run. The gang then turns to and mixes a hopperful of concrete which is placed before any more mixing is done. As an entire run takes only 5 or 6 yd. of concrete, the work can be done by a few men. The finishing is the big item, this amount of concrete requiring the finishing of 630 to 840 sq.ft. Before the concrete has hardened each slab is marked with the date.

Other Articles of Interest to Contractors In This Issue:

Construction Teamwork Builds "Eagle" Plant in Two Months — Page 755
Commercial Body Takes Up Vocational Education — Page 760
Expect Increased Use of Machinery on Iowa Road Maintenance — Page 761
Suspension Bridge Aqueduct Twice Built in Six Weeks — Page 761
Thirteen-Thousand-Ton Vessel Righted by Rolling and Lifting — Page 764
Traveler Handles Forms and Steel for Ore Deck — Page 768

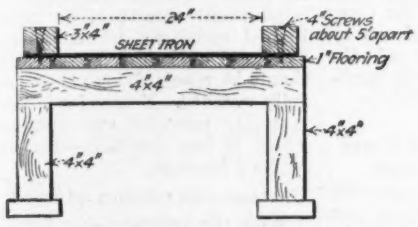


COMPACT YARD SERVED BY MIXER, TRAVELING HOPPER AND DERRICK



THE SCREW PLUGS HOLD BOLT SOCKETS

After being allowed to set for two to five days, according to conditions, the strips are removed, the blocks turned around crossways on the form, and the small traveling derrick comes along and picks them up and stacks them for curing. The derrick is fitted with a lifting rig made of a square frame of ¾ x ¾-in. angles about 2 x 4 ft. in plan, which is hung horizontally from the hook with light wire rope. From

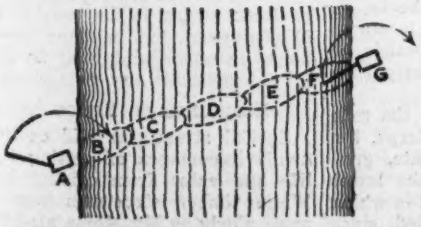


THE SIDE FORMS ARE HELD ON BY SCREWS

the corners of this frame are suspended two long strips of 4-in. belting, one at each end. These flexible strips are slipped under the ends of the slabs, and can be used to raise anywhere from one to six at a time. The slabs are separated by 1-in. wooden strips in stacking and handling. They are distributed along the line of the elevated in motor trucks and hoisted to the deck with a light outrigger and electric hoist.

Dragline Crosses Stream by Picking Up And Laying Down Islands

DRAG-LINE excavators possess qualities peculiarly their own in making paths for themselves when required to travel from one location to another. At Dayton, O., a large drag-line excavator working on channel improvement has crossed the Miami River several times without a boat, or getting its feet wet, or flying. The sketch explains the method used. Starting at A the machine, excavating from the bank, builds a peninsula, B, out into the water and moves out onto it. From its new stand it picks up the peninsula behind and lays it down as an island, C, onto which it moves. From there it picks up island *C*, and lays it down as island D. These operations are continued until the excavator reaches the point G, when it picks up the last island and leaves the channel as clear of obstruction as it was originally. No great depth of water existed at the crossing. The dragline which made the crossing was one of the largest sizes, with a 100-ft. boom and a 4½-cu.yd. bucket. It is working on the flood protective works of the Miami Conservancy District.



DRAGLINE CROSSES STREAM BY BUILDING ISLANDS

Currency in the Pay Envelope Confounds the Dram Shop

ANY consideration of labor efficiency which fails to recognize the human side of the workman is bound to fail. Returning recently from a half day's travel about the operations of a war-time job in a large mid-western city, the editor and his contractor host arrived at headquarters as the procession of workmen was filing past the pay clerk's window. Watching the men as one after another they tore open their envelopes and pocketed their money, the contractor remarked: "Wages should never be paid by check, and always in bills of small denomination." He went on to say, noting his guest's look of interest, "It keeps the men out of the saloons." "Merely a notion," is the first thought. Further thought, however, develops reasons. Few workmen have other than a savings-bank account if they have even that banking relation, and their hours of work make a visit to the bank impracticable under any circumstances. Consequently, they go to the saloon to get cash for their checks or change for their large bills. The saloon keeper is glad to accommodate; he requires no identification, asks no embarrasing questions, and does business through no supercilious clerk. Custom decrees that the man accommodated shall stand treat. One treat begets another, and if the saloon keeper plays his game well he gets back into the till a fair percentage of the currency he passed over the bar. One of these gentry once boasted to the editor that he got back 25% of every check he cashed.

Perhaps this was an exaggeration, but the mere fact that he dared to make so great a claim indicates that the actual percentage was not inconsiderable. Besides the money tax which the saloon bank levies on the workman, it deals out to him the poison which makes of him a less efficient, if not an irregular, workman.

All this is why the wise contractor has scant use for the saloon bank, and why the particular contractor referred to above took pains to make certain that by no action of his should his workmen have reason to visit a saloon on pay day. Pay in currency and in bills of small denominations, and the workman won't go to the dram shop—at least he won't go there to get his earnings transformed into the medium of exchange which he can conveniently employ. C. S. H.

NEWS OF THE WEEK

New York, October 24, 1918

St. Paul Engineers Urge Reconstruction Measures

Adopt Resolutions for Taking First Steps in Planning for Return of Army

Resolutions urging public officials and private interests to take immediate action in formulating plans for reconstruction work, with a view to furnishing employment to a large number of men who will be available as soon as the war is over, were adopted by the Engineers' Society of St. Paul at a meeting held Oct. 14. An interesting discussion on "After-the-War Problems for Reconstruction" was a feature of the meeting. The discussion was based on the following questions: "What is the attitude of the engineer and of engineering organizations to the returning soldiers, particularly the engineering units, and what should be done for making available for homes the large tracts of state-owned lands in Minnesota?"

The following is the text of the resolution adopted by the society:

"Whereas, we believe that the matter of furnishing employment to the great number of returning soldiers and men released from the ship-building yards, munition factories and other war industries presents a serious problem, and

"Whereas, a large field for the employment of both skilled and common labor can be provided by promptly undertaking the construction of extensive public improvements, such as highways, paving, bridges, sewers and waterworks, and also of private projects, many of which have been suspended during the war, and

"Whereas, before such construction work can be started it will be necessary to formulate plans for the work and to do much preliminary work which often requires several months,

"Be it therefore resolved, that public officials and private interests who will have such construction work in charge be urged to take immediate action toward completing the preliminary steps and formulating plans for such construction work, so that when the war is over the actual work of construction can be started promptly, thereby furnishing employment to a large number of men at the time when it will be urgently needed and at the same time helping to revive the non-war industries and to reëstablish normal conditions."

A committee was appointed to make a report upon the state's resources for furnishing farm homes for those adapted to farming. This work will be conducted along the lines laid down by the committee of the National Research Council.

Heavy Artillery Wants Engineers for Officers

Artillery in the United States Army is divided into field artillery and heavy (coast) artillery. The former has its officers' training school at Camp Zachary Taylor, Louisville, Ky.; the school for the latter, which handles all of the big guns, is at Fortress Monroe, Virginia. A special appeal is now being made to engineers to offer their services for the heavy artillery officers' training camp.

Men in deferred classification, due to dependent families, have the option, if they do not gain commissions, of reverting to their previous civilian status, or remaining in the service as enlisted men. Otherwise they take the same chance as if they were selected by their draft board and assigned to the heavy (coast) artillery.

Full information will be obtained by writing to the Commandant, Coast Artillery School, attention of the Communication Officer. The school can induct any registered citizen of the United States who is physically qualified for general military service.

Concrete Ship "Faith" in Good Shape After Long Voyage

The "Faith," the 4500-ton concrete freighter which was launched in San Francisco last spring, has successfully completed a trip from the Pacific Coast to the west coast of South America and from there, laden with nitrates, through the Panama Canal to New Orleans. It is reported that she had a very successful trip so far as ease of handling is concerned, and that structurally she is quite satisfactory. No cracks were observed in the beams or girders. It is expected that the "Faith" will sail soon for New York.

More Funds Are Asked To Buy Technical Books for Soldiers

At the head of the list of books sought by the American Library Association for the American Army are technical works relating to special branches of army service. The association is making a drive for $3,500,000 instead of a contribution of books, as was originally asked for. It is stated that it has been found impossible to build up camp libraries properly with hit-or-miss contributions.

The association states that the men in the Army—the Aviation Corps, the Engineer Corps, radio students, gunners, signal men—all want the latest and best books on the subjects in which they are particularly interested, since the men realize that extra rating and early transfer overseas depend largely on study.

Railway Bridge Men Hold 28th Convention

Urge Utilization of Full Life of Structures as War Necessity—Wood Tanks Advocated

How to adjust railway practice in the maintenance and renewal of structures, in order to meet the war conditions affecting labor, material and finance, was the dominant question at the 28th annual meeting of the American Railway Bridge and Building Association, held in Chicago Oct. 15-16.

Necessity for reducing new construction to a minimum and providing continual repair and maintenance of existing structures under these war conditions was emphasized by C. A. Morse, formerly chief engineer of the Rock Island lines and now director of maintenance in the operating division of the United States Railroad Administration. He considers it not now advisable to rebuild small structures on account of limited waterway, unless there is real danger of washouts. The old structures should be repaired, kept clear and carefully watched. Economize in work that is really essential and postpone that which is less essential—this was Mr. Morse's message.

Universal Standards in Bridge Work

With the railways now forming one Government-owned system Mr. Morse urged standardization of methods and plans in bridge work. There is greater variety in practice than any one railway would have permitted on its own lines, and there is opportunity now to crystallize the good and eliminate the poor in such practice. He suggested that the association should take up this matter in its work for the coming year.

As to buildings, the enormous amount of Government work will, it was brought out, exercise a check on railway work. Few new stations will be required, but attention should be given to keeping the existing structures in good repair and well painted, as a means of extending their lives and of giving good appearance, so as not to arouse public objection. New buildings may be required for the mechanical department owing to the increase in size of equipment, but in many cases sufficient accommodation may be obtained by enlargements and extensions.

Economics of Bridge Repair

Special stress was laid on the economic importance of getting the full life and value from existing bridges. While timber structures were noted particularly by Mr. Morse, steel bridges were considered at considerable length in a paper on "Carrying Bridges Over," by C. F. Loweth, chief engineer of the

Chicago, Milwaukee & St. Paul Ry. Deterioration and overloading are the principal reasons for renewal. Methods of systematic study of the conditions of old bridges carrying increased or comparatively heavy loads were reviewed, together with possible means of reinforcement and discussion of the economic question as to whether replacement or repair is the more desirable.

That more frequent inspection must accompany the policy of carrying over old bridges by means of continual repair work was one of the points brought out in the discussion. Such inspection must be planned specially to guard against failure of details. On one railway, where refrigerator cars are a cause of corrosion in stringers and floor-beams, it is now the practice to clean off the brine frequently and apply patches of paint. As to overloading, many old bridges will carry a moderate or even considerable increase in load without reinforcement, but these structures should be inspected frequently and watched for any signs of distress. It was stated that girder bridges placed on the New York Central R.R. in 1880 are still in service, carrying the greatly increased loads of modern equipment.

Repairing and strengthening of old masonry was the subject of a long report which included a description of the underpinning of a washout under the Coon Rapids Dam, taken from *Engineering News-Record* of July 25, pp. 186-189. This led to a discussion in which individual jobs and experiences were noted. The suggestion was made that when indications of failure appear more study should be given to their causes and remedy, instead of the assumption being made at once that reconstruction is necessary.

Movement of an old stone pier in an important bridge was investigated and repair decided upon. Vertical I-beams were bolted to chases dressed in the stone and covered with a concrete jacket to protect the masonry. After this had set, a new grillage was placed under one end of the footing and no further work has been required. In other cases old brick arches were condemned on account of apparent signs of failure. On investigation, however, it was found the trouble was in the footings. These were reinforced, and the arches are likely to continue in service indefinitely.

Material for Water Tanks

Wooden tanks were advocated strongly in a paper by C. R. Knowles, superintendent of water service, Illinois Central R.R. High cost of steel and prohibition of supply of steel for tanks make wood economical, he said. Wood-stave pipe of small diameter was suggested also as a possible substitute for iron pipe in some cases. Little was said as to concrete tanks. Discussion brought out reference to many long-life wood tanks and to troubles with modern steel hoops as compared with old-time wrought-iron hoops. Methods of frost-proofing where temperatures go far below zero were also discussed.

Bridge decks and guards were the subject of a brief report which advocated the use of tie-plates on bridge ties and stated that at least one railway places them also under the inside guard rails. Standard spacing of girders and stringers was recommended, so as to permit of uniform length of ties and uniform spacing of outer guard timbers.

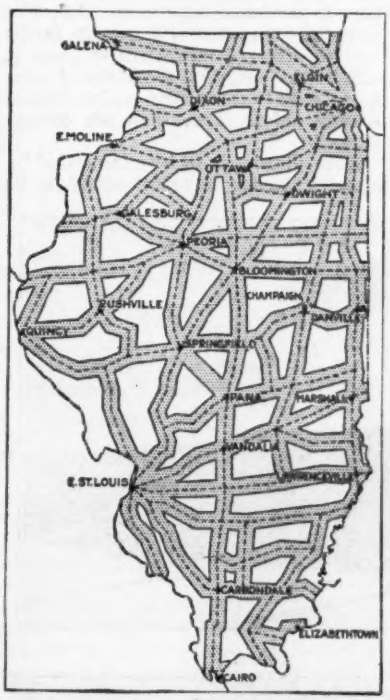
Labor-saving devices in use by bridge and building forces were noted in another report.

Lee Jutton, division engineer, Chicago & North Western Ry., was elected president; C. A. Lichty, Chicago, is secretary. The next meeting is to be held at Cleveland.

Illinois to Vote on Great Highway System

$60,000,000 Bond Issue Planned to Put 85 Per Cent of Population Within Five Miles of Roads

A great after-the-war project for good-road work in Illinois comes up for decision on Nov. 5 when the public will vote on a $60,000,000 bond issue for a 4800-mile hard-surface road system. A strenuous campaign of education has been under way for six months by an organization created for the purpose, for it is believed that although the project has merit in every way people will not vote for additional expenditures in these times unless for some good reason which is made perfectly clear in their minds. Literally, tons of literature have been distributed. Addresses by the thousand have been made, and organized efforts have been carried into each county, city and town in the state. A 2000-ft. moving picture reel, "Over Unchanged Roads in a World of Change," depicting conditions existing and as they might be, with suitable "sales talk" between scenes, was made last summer. The moving picture outfit traveled 3000 miles, all over the state, guided by engineers, for a month and a half. Ten prints were made up and booked to be shown all over the state. Unfortunately, the educational value will be materially lessened, due to the closing of all moving picture theaters Oct. 15 by the State Board of Health in an attempt to curb the epidemic of influenza. Particular efforts have been made to reach the laboring classes through their unions. Gov. Frank O. Lowden and other notables have been rushed on speaking tours from shipyard to steel mill, from universities to farmers' institutes.



EIGHTY-FIVE PER CENT. OF PEOPLE IN ILLINOIS LIVE WITHIN FIVE MILES OF PROPOSED $60,000,000 ROAD SYSTEM

The principal arguments used in these brief talks are as follows: The automobile owner will pay the bills; no additional taxes are to be levied; no bonds will be sold until after the war; $30,000,000, or one-half of the money, will go for labor; 65% of the people live on the roads and 85% of the people live within the five-mile zones paralleling each side of the system; and after-the-war work should be provided for the reconstruction period.

Canada May Have To Ration Electric Power

The seriousness of the electric-power situation in Canada, if the demand is increased, may make it necessary for the Government to resort to rationing, according to an opinion expressed by Sir Henry Drayton, Canadian power controller, at a conference on the power situation held in Toronto, Oct. 18, by the Canadian Manufacturers' Association, Sir Henry Drayton and Sir Adam Beck, chairman of the Ontario Hydro-Electric Power Commission. It was stated, however, that the rationing of power consumers would not be undertaken except in the greatest emergency.

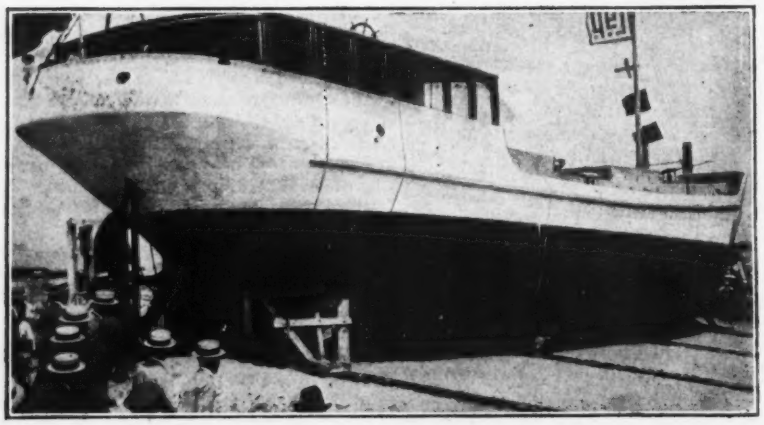
One source of possible relief seemed to be in the curtailment of the quantity of power delivered to the United States, which at present is about 108,000 hp. Sir Henry said he would take the question up with the authorities in Washington, and hoped it might be possible to secure some portion of the power for Canadian consumers. The suggestion of power rationing was opposed by Sir Adam Beck, on the ground that such a restriction would necessitate the laying off of workmen on stated days, adding to the difficulty of manufacturers in maintaining their working forces, which difficulty is already great. He expressed his opinion that if every source of supply, including stream power, were utilized, and consumers coöperated in conserving power, it would be possible, with the additional 50,000 hp. which will be available in a few weeks, to continue as at present without adopting drastic measures.

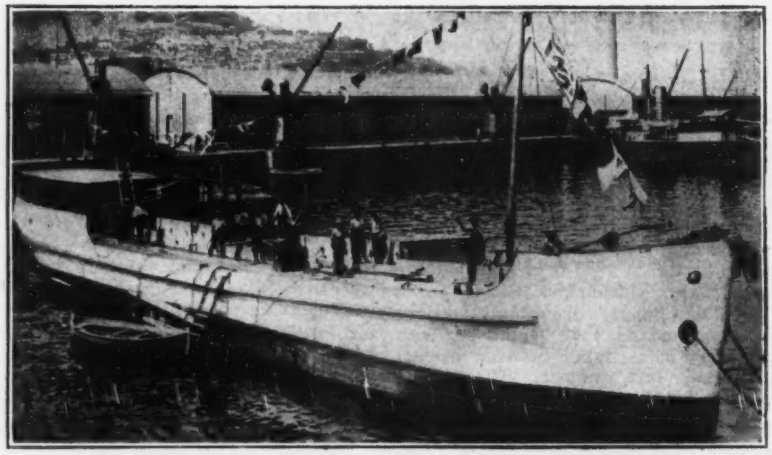
France to Operate Her Railways During Remainder of War

A bill to put the railroads of France under government operation during the remainder of the war, and for a year thereafter, is to be introduced into the Chamber of Deputies, the Council of Ministers having approved such a plan. Hitherto the railroads have been run under the management of their respective boards of directors, subject to a general undertaking to give priority to the transport of all troops and war material.

Experimental Concrete Ship Built in Spain

A small concrete ship, driven by Bolinder oil engines, has recently been launched at Barcelona, Spain, by the Construcciones y Pavimentos Co., a well-known Spanish concrete construction firm. The two views show the ship, on the ways just previous to its side launching, and in its berth after launching. The size of the boat has not been reported by its builders, but it appears to be about 200 tons burden. It was built as an experiment, and the announcement is made that the success of the trial is such that the company will start the construction of 1200-ton boats.





SMALL CONCRETE SHIP JUST LAUNCHED AT BARCELONA, SPAIN.

Central Repair Units for Motor Transport Corps

War Department Divides United States Into Districts for Upkeep of Its Motor Equipment

Division of continental United States into six districts, each of which will be served by a central repair unit, to facilitate the maintenance of the motor equipment used in this country, is covered by General Order 86, issued by the Army General Staff. New machines only are sent to the American Expeditionary Forces, but, in order that the steady flow of them may be maintained at a maximum, the old trucks that serve the Army's needs here must be kept in service as long as possible. The new district system will greatly facilitate repairs and reconstruction, and it will be the policy of the Motor Transport Corps to discourage major repairs at any points other than the central units.

Each district is to be commanded by a district motor transport officer, to be appointed by the chief of the corps. He will have, under the authority of the chief, control and supervision of all matters pertaining to the operation, maintenance and repair of class 1 vehicles and a technical supervision of class 2 vehicles. Class 2 vehicles are those assigned to various units outside the corps. The corps is responsible only for their repair and maintenance. Class 1 consists of all vehicles operated directly by the corps and also the new trucks that are moved from the factories to the seaboard in convoy, relieving the railroads by moving under their own power and by loading with Government freight. Thousands of tons are being moved in this way all the time, states the order.

The repair units are located at Camp Holabird, Baltimore; Atlanta; Fort Sam Houston, Texas; El Paso, Texas; Chicago, and San Francisco. The most important one is that at Camp Holabird, because it serves the largest district and the one that contains nearly all the important truck factories and all the principal ports of embarkation for France. The states in this district are: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia, Virginia, Kentucky, Ohio, Indiana, Michigan (lower peninsula) and the District of Columbia.

Water-Works Experience Meeting

The opening meeting of the New York Section of the American Water-Works Association, Oct. 16, was devoted to practical experiences. A new feature was an exhibit of models of various important structures connected with the Catskill Aqueduct.

In the enforced absence of George C. Andrews, water commissioner of Buffalo, E. D. Case, manager, the Pitometer Co., New York City, outlined the water-waste survey, now being carried on in Buffalo, which has resulted in a material reduction in water consumption and waste.

John M. Diven, secretary of the association, spoke briefly of the vigorous canvass of water consumption and waste which is being undertaken by the United States Fuel Administration. He thought that this survey will accomplish more to reduce consumption and excessive coal use than many years of effort of water-works men. If necessary, the Fuel Administration will issue notices to water-wasting cities limiting the amount of coal that they may use at their water-works pumping stations during the coming winter.

Aviation Corps Has Problem for Instrument Men

The need for a special compass, which could be placed near the outer end of an airplane wing and at the same time could be read from the driver's seat, is pointed out in a circular issued by the invention section, General Staff, Army War College, Washington, D. C., which invites ideas and suggestions. It is explained that on night bombing expeditions and even in the day time, when passing through fog or clouds, an airplane is guided entirely by compass. Unfortunately, the instruments now in use, placed where the aviator

can see them, are directly between him and the engine, a position which greatly affects their accuracy.

If a compass could be placed near the outer end of a wing, or at the rear end of the fusilage, it would be practically outside of the magnetic influence of the engine, but at present there is no way to read a compass in either of those positions. What is needed is some device or arrangement whereby a compass can be mounted far enough away from the engine to be outside of its magnetic influence, and still be so arranged that it can be easily read by the aviator.

Ideas and suggestions should be sent to the invention section, General Staff, Army War College, Washington, D. C.

Plan Motor-Truck Highway Along Chicago Drainage Canal

After-war construction of 50 miles of hard roads leading out of Chicago, and intended specially for motor-truck freight haulage, is the plan of the Sanitary District of Chicago. This will utilize the unoccupied right-of-way of the drainage canals and the piles of waste rock remaining from the original excavation. There would be a 30-mile route along the main drainage channel from Chicago to Joliet, a 10-mile line along the Sag channel to South Chicago, and an 8-mile line along the North Shore channel to Wilmette. A committee has been appointed to take up the matter with the public authorities and, if necessary, to obtain legislation granting power for the construction of these roads.

To Study Port Improvements at Vancouver

Vancouver, B. C., is to be studied by the Canadian Government with a view to improving its port facilities. The Minister of Marine and Fisheries has decided to send A. D. Swan, harbor engineer, to Vancouver to report on a policy of local harbor development and equipment to cover the requirements of the port for the next twenty years. Greater wharfage facilities are seriously required, and appliances such as traveling cranes are needed. The construction of a terminal railway to connect up the main harbor with English Bay and False Creek is projected, and also the construction of a series of wharves on the English Bay harbor, which has hitherto been neglected for shipping

Motor Trucks Prominent in Forest Fire Relief Work

In the forest fires which took place in the Moose Lake district in northern Minnesota, during the week beginning Oct. 12, many villages being destroyed and several hundred lives lost, relief rendered by automobiles and motor trucks through the Minnesota Motor Reserve Corps was credited with being the most valuable aid employed in fire-fighting and relief work in the district, according to a statement made by Attorney General Clifford L. Hilton on his return from the fire zone.

Army Construction Division Wants Surveyors

Announcement has been made by the United States Civil Service Commission in Washington that the Construction Division of the Army is in urgent need of a number of surveyors. Present calls are for 50 chiefs of survey party, at $2700 to $3000 a year, 50 transitmen at $2400 a year, 25 levelmen at $2100 a year, 125 rodmen at $1800 a year, 150 chainmen at $1800 a year, and 50 topographic draftsmen at $2100 a year. These positions are open to men only, except the drafting positions, which are open to both men and women. All the positions are in the civil, not the military, service.

Persons interested should apply to the United States Civil Service Commission, Washington, D. C., or to the secretary of the local board of civil service examiners in Boston, New York, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, St. Louis, New Orleans, Seattle or San Francisco. Applicants will not be required to undergo a written examination, the examinations being of the nonassembled type; that is, the ratings will be based upon education, training, experience and physical ability, as shown by the application and corroborative evidence.

Federal Government Helps Locate Bankhead Highway

Federal Government highway interests are represented upon the Bankhead Highway Location Commission by M. O. Eldridge, of the Office of Public Roads and Rural Engineering, according to an announcement made by J. A. Rountree, secretary of the Bankhead National Highway Association. The commission, which will locate the highway between Memphis, Tenn., and El Paso, Tex., consists of four representative and disinterested citizens living east of the Mississippi River, and this member from the Office of Public Roads.

Work has been started already, a beginning having been made at Memphis Oct. 15. Several routes are suggested between the various cities connected, and it will be the duty of the commission to select the most desirable of these. Mr. Rountree will be in charge of the party on a trip which will take about five weeks.

Camp Mills To Be Made Permanent Cantonment

The plans for transforming Camp Mills, Garden City, L. I., from a tent city into a permanent cantonment, involve an estimated cost of $13,000,000, which includes an item of $2,500,000 for a 2500-bed hospital that is to be located at Mineola. According to plans, the camp will have accommodations for 50,000 men, which is five to fifteen thousand greater than any of the original cantonments. It is said that the explanation of any increased cost that is noted in the estimate for Camp Mills lies largely in the increased labor cost over that which obtained a year ago, but that this is not large when the fact is considered that a larger number of men are to be housed in Camp Mills than in any of the other cantonments. It is pointed out that the 16 original cantonments cost from $6,000,000 to $12,000,000 each, instead of $3,000,000 as originally estimated.

The construction at Camp Mills is to be lumber and not brick.

Cleveland Society Opens Doors to Other Organizations

By a vote of 142 to 7, the Cleveland Engineering Society has changed its constitution so that it may now have joint members with any other engineering or technical organization in the United States or Canada. Details of arrangements as to splitting of entrance fee and dues are left open so that they may be suited to the occasion. A special feature is that no initiation fee is to be charged an applicant if he has already paid one to another society. As to qualifications, joint members become members on application and election, as provided for any other applicant.

This action ratifies the joint arrangement effected some months ago by the board of directors with the American Association of Engineers.

Research Council Wants Information on Laboratories

The Engineering Foundation and the National Research Council are cooperating in the compilation of information concerning research laboratories throughout the country, and in the promotion of industrial research. It is the purpose to aid the Government and the war industries through the advancement of American industry, engineering and science. To this end all laboratories are requested to send to the New York office of the Research Council a brief statement covering the following: Equipment; capacity for research work, and members of staff.

ENGINEERING SOCIETIES

The Iowa Section of the American Water-Works Association has indefinitely postponed its fourth annual meeting, on account of the influenza epidemic. The meeting was to be held Oct. 23-24 in Iowa City, as mentioned in *Engineering News-Record* of Oct. 3, p. 648.

The Kentucky Highway Engineers' Association, formerly the Kentucky County Road Engineers' Association, will hold its annual convention Nov. 12-14 at Owensboro. It is planned to have only a few of the addresses made indoors, but to have practically everything that pertains to the building and maintenance of roads delivered in the open on the road where the work is in progress. The program includes out-

Calendar

Annual Meetings

CITY MANAGERS' ASSOCIATION; Harrison Grey Otis, Auburn, Maine, secretary-treasurer; Nov. 6-8, Roanoke, Va.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS; A. Dennis Williams, Morgantown, W. Va., acting secretary; Dec. 2-6, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS; 29 West 39th St., New York City; Dec. 3-6, New York.

AMERICAN PUBLIC HEALTH ASSOCIATION; 126 Massachusetts Ave., Boston; Dec. 9, Chicago.

door lectures on the following subjects: "Macadam Maintenance"; "Ditching on Surfaced Roads;" "Earth-Road Maintenance and Ditching"; "River-Gravel Road Construction and Maintenance"; "Bank-Gravel Road Maintenance and Construction"; "Bridge Painting" and "Rock-Asphalt Surfacing."

The San Francisco Association of Members of the American Society of Civil Engineers was addressed at the meeting Oct. 15 by Herman Schussler, who delivered an illustrated talk on "The Construction of the Copco Dam on Klamath River." Mr. Schussler described interesting tests of concrete and other materials, the largest gate valves ever built on the Pacific Coast, and general features of California's latest hydro-electric development.

The New York State Waterways Association will hold its ninth annual meeting Nov. 7-8 in Brooklyn, under the auspices of the Brooklyn Chamber of Commerce. United States Senator William M. Calder of New York and James Sherlock Davis, president of the Brooklyn Chamber of Commerce, are included in the list of speakers. Senator Henry W. Hill of Buffalo is president of the association and Edwin T. Coffin of Albany is secretary.

The Detroit Engineering Society will be addressed Nov. 8 by Lieut. G. I. Back, technical adviser in the training department of the course for telephone electricians, University of Michigan, who will speak on the work of the Signal Corps. The meeting will be held under the auspices of the American Institute of Electrical Engineers, members of the Detroit Engineering Society being invited.

The Houston Engineers' Club, Houston, Tex., at its annual meeting Oct. 10, was addressed by Prof. A. Deussen on "The Origin and Production of Petroleum." The following officers were elected: President, J. C. McVea; first vice-president, F. C. Smith; secretary-treasurer, F. P. Risdon.

The Engineering Society of St. Paul was addressed by L. P. Wolff on "The Engineering Features of Camp Dodge," at the meeting Oct. 14.

PERSONAL NOTES

L. C. FRITCH, formerly general manager of the Seaboard Air Line Ry., has been elected vice president of the corporation of the Rock Island lines, and also vice-president of the Minneapolis & St. Louis R.R. Co. Mr. Fritch, past president and one of the founders of the American Railway Engineering Association, was chief engineer of the Chicago Great Western R.R. from 1909 to 1914. In the latter year he was appointed assistant to the president of the Canadian Northern Ry., and the following year was made general manager of the eastern lines. Subsequently he went to the Seaboard Air Line Ry. as general manager, remaining at that post until a few months ago, when a Federal manager was appointed by the Railroad Administration.

L. F. LOREE, chairman of the board of directors of the Kansas City Southern Ry., has been elected president. Mr. Loree is an engineer and was in engineering work about 12 years before going into railroad operation.

MAJ. G. B. STRICKLER, Construction Division, U. S. A., who was commissioned in July, 1917, has been promoted to the rank of lieutenant colonel and assigned to duty as constructing quartermaster, Camp Hancock, Augusta, Ga.

H. D. HAMMOND has resigned as managing editor of *Engineering News-Record* to join the forces of the Lakewood Engineering Co., with headquarters in Philadelphia. Mr. Hammond studied for two years at Vanderbilt University, Nashville, Tenn., and later at the Sheffield Scientific School, Yale University, from which he was graduated with the degree of Ph.B. in 1908. He entered the engineering field in 1909 with the Foundation Co. in New York City, where, except for a few months with the American Bridge Co. he remained until 1914. He joined the editorial staff of *Engineering Record* in 1915 and his work since that time has been largely in the construction field.

C. LOOMIS ALLEN, who has retired from the firm of Allen & Peck, Inc., engineers and managers of public utilities, Syracuse, N. Y. and Baltimore, as mentioned in these columns last week, has entered private practice, under his own name, in general engineering and management of public utilities, with offices in the Vinney Building, Syracuse.

W. C. CURD, contracting engineer for the Layne & Bowler Co., Memphis, Tenn., has resigned to enter the service of the William Graver Tank Works, Chicago. Mr. Curd, who was educated at Purdue University, was in the employ successively of the Southern, Louisville & Nashville, Union Pacific and Missouri Pacific railways, before going to the railroad department of the Layne & Bowler Co. He was with the Missouri Pacific Ry. 11 years, first as assistant engineer and later as drainage engineer.

A. A. MILLER, engineer maintenance of way of the Missouri Pacific Ry. at Little Rock, Ark., has been transferred to Kansas City and his title has been changed to district engineer. He succeeds J. R. Leighty, whose appointment as chief engineer of the corporation was noted in these columns Oct. 10.

C. S. HERITAGE, bridge engineer, and R. E. Van Atta, principal assistant engineer of the Kansas City Southern R.R., have had their jurisdiction extended to include the Missouri & North Arkansas R.R. Their offices remain at Kansas City, Mo.

LIEUT. D. A. TOMLINSON, coast artillery, Fort Monroe, Virginia, who was formerly assistant engineer, Chicago & Western Indiana Ry., has been promoted to the rank of captain.

W. M. NEPTUNE, assistant engineer of the Missouri Pacific Ry. at St. Louis, has been appointed principal assistant engineer, with charge of drainage, flood and river protection.

MILTON J. RUARK, chief of the municipal bureau of drafting, Baltimore, has been appointed engineer in charge of sewers and will be attached to the highway engineer's department. Mr. Ruark's headquarters will be in the health department building. He succeeds Thomas D. Pitts, who resigned several months ago, as mentioned in these columns, to enter the service of the United States Shipping Board.

CAPT. CHARLES T. LEEDS, Corps of Engineers, has been promoted to the rank of major and assigned to duty as district military inspector for the territory including California, Nevada and Utah.

J. A. LAHMER, drainage engineer of the Missouri Pacific Ry. at St. Louis, has been appointed district engineer at Little Rock, Ark. He succeeds A. A. Miller, the title being changed from engineer maintenance of way to district engineer.

T. L. PHILLIPS has been appointed division engineer of the western division of the Western Pacific R.R., with headquarters at Sacramento, Cal.

LIEUT. COL. WILLIAM BARCLAY PARSONS, of New York City, has been promoted to colonel of engineers, and is now in command of the Eleventh Engineers at the front. This is one of the early railroad regiments

which went over to France the beginning of last summer Colonel Parsons has been attached to it since that time.

V. V. KIRKPATRICK has been appointed valuation engineer of the Missouri & North Arkansas R.R., with office at Kansas City, Mo.

EDGAR B. THOMAS, member of the committee on development of the American Society of Civil Engineers, mentioned in *Engineering News-Record* of Oct. 10, p. 688, as having advanced in the city engineering department of Cleveland from transitman to chief engineer, should have been mentioned as having advanced from transitman to engineer in charge of the river and harbor development department, which is a subdepartment under the chief engineer.

H. J. ARMSTRONG has been appointed division engineer of the Missouri & North Arkansas R.R., at Harrison, Ark.

G. H. BALLANTYNE has been appointed division engineer of the eastern division of the Western Pacific R.R., and has jurisdiction also over the Deep Creek R.R. His office is at Elko, Nev.

OBITUARY

LIEUT. CHESTER H. PLIMPTON, 21st Railway Engineers, who was previously plant engineer for the American Malleables Co., Lancaster, N. Y., was killed in action Sept. 27. He was 25 years old and a graduate of Yale University in the class of 1914.

LIEUT. ROBERT JOHNSTON, a civil engineer lent to the Canadian Government by the United States in connection with the construction of naval air stations on the coast, died in Ottawa, Oct. 14.

WILLIAM ARTHUR O'BRIEN, chief engineer of the Little River Drainage District, Cape Girardeau, Mo., died from influenza Oct. 12, at the age of 35. Mr. O'Brien entered engineering work in 1903 as a rodman and instrumentman for the Terminal R.R. of St. Louis, soon afterward going to the Chicago, Peoria & St. Louis Ry. as assistant engineer. From 1906 to 1907 he was assistant instructor in railway engineering at Purdue University, after which he became assistant engineer for the Terminal R.R. of St. Louis. In 1908 he became principal assistant engineer of the Little River Drainage District and shortly afterward became a member of the board of engineers on this work, which involved the reclamation of 550,000 acres of land in southeastern Missouri. From 1909 to 1910 he was chief engineer of the Chicago, Peoria & St. Louis Ry. He became chief engineer of the Little River Drainage District in 1910.

LEONARD S. CAIRNS, general manager of the Eastern Pennsylvania Railways Co., died Oct. 10, at Pottsville, Penn. He was 36 years of age. For a number of years Mr. Cairns was general superintendent of the Twin City Rapid Transit Co., of Minneapolis and St. Paul. In 1912 he resigned from the operating organization of that company to join the staff of the J. G. White Management Corporation, New York City, and was assigned to the position of assistant general manager of the Manila Electric Railroad & Light Co., Manila, P. I. He was promoted by the management corporation in 1917 to the office of general manager of the Eastern Pennsylvania Railways Company.

A. N. BULLITT, who was assistant chief engineer of construction for the St. Louis-San Francisco system from 1894 to 1904, died in Memphis, Tenn., Oct. 8. He was resident engineer in charge of the construction of the Arkansas River bridge at Little Rock. After 1904 he was chief engineer of construction for the Mobile, Jackson & Kansas City Ry. and the Gulf & Chicago Ry. Until the merger with the Norfolk & Southern he was in the service of the Virginia-Carolina Coast Ry. He went to Memphis several years ago to engage in municipal improvement work, specializing in the construction of drainage tunnels. During the last two years of his life he was engaged in highway construction work. Recently he completed a 21-mile highway in Mississippi.

JULIUS L. JACOBS, southern manager for James Stewart & Co., contractors, died of pneumonia at Norfolk, Va., Oct. 2. Mr. Jacobs was born in Texas in 1882 and was graduated with the degree of B. Sc. from the University of Texas at the early age of 17. He then entered Cornell University and was graduated with the degree of C. E. in 1904. After three years of railway work he entered the employ of James Stewart & Co. in February, 1907, and at the time of his death was in charge of the many contracts of that company in the Hampton Roads district.

OGDEN MERRILL, of the firm of Merrill-Ruckgaber Co., contracting engineers, New York City, died Oct. 5. After his graduation from Cornell University in 1899 Mr. Merrill entered engineering work as a rodman for the Arthur McMullen Co. of New York City, later serving as draftsman and inspector for the construction department of the American Smelting & Refining Co. From 1901-02 he served as engineer on the Park Ave. tunnel of the New York subway system under Ira A. Shaler, after which he became associated with the United Engineering & Contracting Co. as engineer and superintendent of the electric pumping station at the Brooklyn Navy Yard. Later he was engaged by the Pennsylvania R.R. as engineer and superintendent on tunnels under the North River, and was with the New York Tunnel Co. in the same capacity on tunnels under the East River for the Rapid Transit Commission. Mr. Merrill had been president of the firm of Merrill-Ruckgaber Co. since 1908.

REID TULL, county highway engineer, Spartanburg, S. C., died at his home in that city Oct. 3. Mr. Tull was 33 years old and a graduate of the North Carolina Agricultural and Mechanical College. After his graduation he spent several years in the West with the United States Geological Survey, after which he was engaged by the Southern Power Co. in locating the line of the Piedmont & Northern Electric Ry. in Virginia. Before his election as city engineer of Spartanburg in 1913 he was resident engineer for the Greenville, Spartanburg & Anderson Ry. He became county highway engineer in 1917.

WILLIAM STEYH, for a number of years city engineer of Burlington, Iowa, died at Sterling, Colo., Oct. 6. At the time of his death Mr. Steyh was in the service of the Chicago, Burlington & Quincy R.R. He was born in Germany in 1845 and came to this country at the age of 21; from that time he made his home in Burlington.

DR. CHARLES S. CAVERLY, professor of hygiene, college of medicine, University of Vermont, and president of the State Board of Health since 1891, died in Rutland, Oct. 16, at the age of 62.

FREDERICK M. DICKIE, editor of the *Pacific Marine Review*, died of appendicitis at his home in San Mateo, Cal., Oct. 11. Mr. Dickie was 35 years of age and a native of San Francisco. He was a son of the late George W. Dickie, naval architect and marine engineer, whose death was noted in *Engineering News-Record* of Aug. 29, p. 427.

J. C. NELSON, engineer maintenance of way of the Seaboard Air Line Ry. at Norfolk, Va., died Oct. 6.

HENRY J. WIDENMANN, member of the California Highway Commission, died Oct. 4 as a result of a hunting accident. Mr. Widenmann succeeded the Hon. Charles D. Blaney, who resigned in 1917.

LOUIS H. MATHER, superintendent of construction for the city of Norwich, Conn., gas and electrical department for the past year, died in that city Oct. 2, in his 34th year. Mr. Mather severed his connection with Stone & Webster Co., New London, two years ago, after having been associated with that company for 12 years.

NEWS OF ENGINEERING INDUSTRIES

FOR MANUFACTURERS WHO SERVE ENGINEERS AND CONTRACTORS

Merchant Marine Creates Need for Consuls

Large Tonnage Available After the War Brings Demand for Larger and Better Paid Consular Force

After a study of our rapidly growing merchant marine and the enormous tonnage that will be available after the war, Edward N. Hurley, chairman of the United States Shipping Board, urges the need for more consuls. They will be necessary to take care of the many details incident to the handling of our foreign trade by this merchant marine. He gives the facts to the nation so that an intelligent opinion may guide Congress when appropriations for the consular service are made this winter.

The United States will have approximately 25,000,000 tons of merchant shipping within two years. Every ton that is delivered now goes into the service to France, but if peace comes soon and this present tonnage is scattered over the world's trade routes, the consular service will be inadequate to handle the business that will result. Not only will there be an insufficiency of men in the consulates, but those that are at work are handicapped by obsolete shipping regulations and in many cases by lack of experience. The lack arises from the fact that until the war brought on a shortage of ships from the European trade and forced American ships into the trans-Atlantic trade, the American flag was rarely seen on any vessel. At Queenstown, Ireland, one of the greatest ports of call in the world, no vessel carrying the American flag had touched in more than nine years until early in 1915, and this is true of other great ports abroad and illustrates the shipping decadence now being remedied.

"Of course, there is no question about the high character of our consular service," said Mr. Hurley, "but we have some splendid officials abroad working at salaries far below what they might obtain by leaving the service and entering private employ. There are not enough of them and they are not justly compensated, and several consuls have died or broken down in health during the past year under the strain of overwork imposed upon them by war conditions."

Mr. Hurley states that there is not only a need for more consuls and larger consular staffs to carry on the increased burden of work, but there must be more adequate compensation and a revision of the shipping regulations and other laws and forms that now obtain. These regulations and customs, established at a time when the United States merchant marine consisted of sailing vessels, are therefore obsolete. Chairman Hurley makes this appeal to the country so that when Congress appropriates money to cover the work for the coming year, it will be sufficient to call to the service men of highest education, business and technical experience. "We might look to Great Britain for an example of straight thinking and enterprise in the matter," he asserts. "Despite more than four years of struggle for her national life, she has kept her industries alive, given the best possible service to her customers all over the world, and designs an orderly scheme for reconstruction after the war."

Fuel Priority List Names Only Some Industries Affected

That only a partial list of industrial products is covered in the preference list, issued by the Priorities Committee, on which is based the distribution of fuel, is indicated in a recent bulletin issued by the War Industries Board. It states that priority is being administered generally on iron and steel products, copper and brass products, electrical equipment and the products in which any of these forms an important part. Priority is not being administered at this time on lumber or lumber products, paper or paper products, chemicals, cement, lime, hides, pig tin, tin plates, lime products and other products—the list is too long, the bulletin states, for the giving of complete details. It states that even in the articles mentioned, exceptions will sometimes occur, and recommends that inquiries be addressed to the Priorities Committee of the War Industries Board in respect to any doubtful commodities.

Munitions Patent Board Created by War and Navy Departments

The War and Navy Departments of Washington have established the Munitions Patent Board for the purpose of coördinating the policies of the two departments in patent matters. The membership of the board consists of the Hon. Thomas Ewing, the joint selection of the two departments; Max Thelen, the representative of the War Department, and Pickens Neagle, representing the Navy Department.

The board was formed to consider and adjust patent clauses in contracts, infringement claims, patentability of inventions, compensation for the use of patents, and other miscellaneous questions as to patents which may arise in the two departments. The actions of the board on such matters are subject to the final approval of the Secretary of War and the Secretary of the Navy.

Foreign Demand for American Ready-Built Houses

Interest in American ready-built houses has been expressed in both France and England, according to a report made by John R. Walker, lumber trade commissioner, reported in *Commerce Reports* by the United States Department of Commerce. The report states that manufacturers of such houses who are interested in the European market are requested to send their catalogues to the Bureau of Foreign and Domestic Commerce for transmission to Mr. Walker, so that the latter may be in a better position to answer inquiries.

Labor Department Issues Book Regarding Employment Offices

The bureau of labor statistics, United States Department of Labor, has issued a 100-p. bulletin, No. 241, entitled "Public Employment Offices in the United States." The bulletin is a report of a study made by the United States Bureau of Labor Statistics at the request of a number of organizations throughout the country. It was requested that private as well as public employment agencies throughout the country be studied, but this report covers only the public employment agencies.

The book gives information regarding employment through these public offices, illustrations of employment forms, tabulation of employment headquarters throughout the United States, and other information in tabular form.

Women for State Organizations of Employment Service

Two women, one representative of management and one representative of labor, are to be added to each state advisory board of the United States Employment Service, bringing the total membership of each of these boards from five to seven, and thereby giving women a large share of the responsibility for the administration of the war labor supply program. Hitherto the state advisory boards have been composed of the state director of the Employment Service as chairman, two representatives of management, and two of labor.

Two women are now being added to the original membership of every community labor board, with full voting powers upon all questions coming within the jurisdiction of the board. This changes the personnel of these boards to one man and one woman, each representative of local management, and one man and one woman, each representative of local labor, in addition to one local representative of the Employment Service as chairman.

Ruling Simplifies Export License Procedure

Certain Licenses Will Embody Both Priority Release and Steel Supply Permit

The procedure with respect to export licenses, priority certificates and permits from the Director of Steel Supply for the exportation of commodities has been simplified by a recent ruling (W.T.B.R. 258) of the War Industries and War Trade Boards. It is accomplished by the withdrawal of War Industries Board regulations published July 3, in P. C. form No. 18.

To the application for the license (form X), there should be attached such supplemental information sheets as may be required by the rules and regulations of the War Trade Board in connection with shipments of certain commodities to certain countries and the new supplemental information sheet, form X-26, which was issued by the War Trade Board on Oct. 14. It is announced that applications which have form X-26 attached will not require form X-2.

Priority classification C has been awarded to all articles (on which priorities are issued) which are on the export conservation list of the War Trade Board and covered by export licenses issued on and after Oct. 16. It is stated that the license itself will be evidence that the articles covered by it have been automatically awarded priority classification C. Export licenses, for commodities bearing a higher classification than C must be accompanied by the proper priority certificate and will be forwarded with the export license by the priorities committee without further request from the applicant. Licenses for the exportation of iron and steel especially, or products and manufactures thereof, which are not covered by a specific priority certificate, will in themselves constitute a permit and approval from the Director of Steel Supply for the filling of the orders.

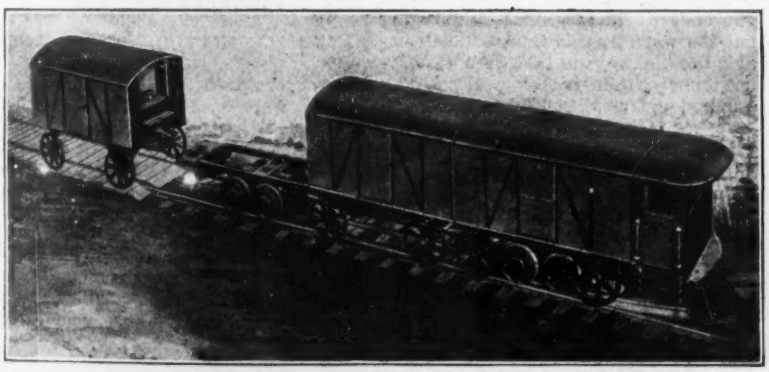
It has been found that manufacturers, have made articles useless for domestic consumption, for specific export orders, before obtaining export licenses, which articles could not be exported under the regulations of the War Trade Board. The notice states that it is essential for the proper conservation of commodities in the United States, that this practice be discontinued, and licenses will be refused to exporters who do not conform to this policy.

Schedule XP, to which this ruling especially applies, includes pig iron, iron and steel scrap, ingot, billet, fabricated structural steel of various sizes, various classes of plates, and sheets, oil well casing, line pipe, various pipe of cast iron, wrought iron, etc.

Rail Wagon Eliminates Rehandling of Freight

A new method of freight collection, haulage and delivery, to do away with rehandling in transit, is to be tested on lines of the Public Service Ry. in New Jersey, if the recommendations of a committee of manufacturing and operating engineers are carried out. It consists essentially of the use of wagons or vans wide enough to be carried astride special railroad carrier cars. The wagons can thus be loaded by the shipper and unloaded by the consignee without intermediate handling or the provision of warehouse facilities.

The "rail wagon" has a body about 16 x 7 x 7 ft., with a capacity of 5 tons. It can be either horse-drawn or motor-driven. The "carrier car" may be either a self-contained gasoline or electric motor car or a trailer car. Its essential features are a low frame that will pass under the rail wagon when it is astride the track, and a jacking device, operated by the air-brake system, for raising the rail wagons clear of the tracks. For the movement of the rail wagons to and from the railroad a third element of the system has been designed—an "auto-hoss," which carries the wagon in the same manner in which it is carried on the railway.



RAIL WAGONS ARE CARRIED ASTRIDE SPECIAL CAR FRAMES

The system is known as the "Bonner Rail-Wagon System." The statement is made that it has been under development for three years, and that the committee that recommended the tests has pronounced it fundamentally sound. The plan is to test it on a line from Paterson to Hoboken, N. J., and also via the Hudson & Manhattan R.R. into New York City.

Business Notes

J. C. Fitzpatrick, formerly manager of the construction machinery department of Gaston, Williams & Wigmore, Inc., 39 Broadway, New York City, has resigned to accept the position of assistant to the president of the American Condenser & Engineering Corporation, 120 Broadway, New York City.

William S. Cetti, representing the Thomson Meter Co., Brooklyn, N. Y., for several years, has resigned his position and announces that his present address is 221 Eastern Parkway, Brooklyn, N. Y.

The Portland Cement Pipe & Tile Co., Portland, Ore., and The Concrete Pipe Works, Vancouver, Wash., have pooled their interests under the name of the Concrete Pipe Co., with principal offices in the Board of Trade Building, Portland. The Concrete Pipe Works had plants at Vancouver, Tacoma and Walla Walla, Wash., and these plants, together with the Portland plant, will be rearranged and enlarged to meet the increasing demands for concrete culvert, sewer, irrigation and drainage pipe.

Trade Publications

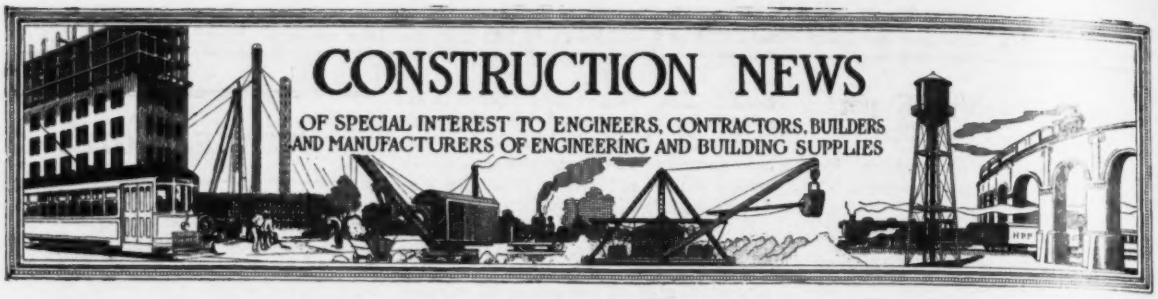
The Beaumont Manufacturing Co., Philadelphia, has issued catalogue 37, giving descriptions, illustrations and dimensions of standard Beaumont gates for controlling the flow of granular material from bunkers. The design of ashpits under boilers and the correct gates to use for this purpose are illustrated.

The White Co., Cleveland, Ohio, has published an 8-p. pamphlet announcing a double reduction gear drive truck. It is illustrated with halftones of the new axle, together with a general description of the truck.

The Armstrong Cork & Insulation Co., Pittsburgh, has published a 37-p. catalogue entitled "Linotile Floors."

Portable conveyors for handling, transferring and stacking freight are shown in a variety of forms and applications in a 48-p. pamphlet, 6 x 9 in., issued by the Brown Portable Conveying Machinery Co., Chicago.

The General Fire Extinguisher Co. has issued the October bulletin of the Grinnell automatic sprinkler. It is a 16-p. pamphlet dealing with hotel equipment, and is called a "special hotel number."

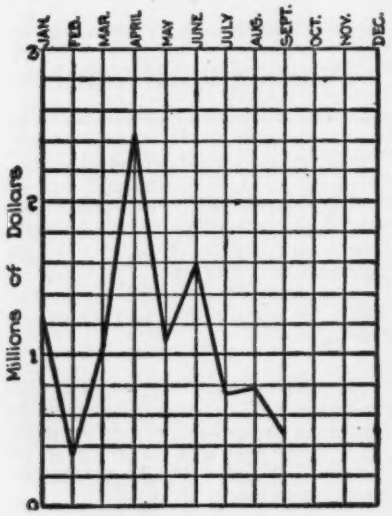

CONSTRUCTION NEWS
OF SPECIAL INTEREST TO ENGINEERS, CONTRACTORS, BUILDERS
AND MANUFACTURERS OF ENGINEERING AND BUILDING SUPPLIES

Bridge Business Falls to Unusually Low Levels

Need of Replacement, However, Makes Revival Probable, According to Various Leaders in the Field

A review of bridge contracts let the first nine months of the year, as reported in the construction news section of *Engineering News-Record*, shows not only relatively small totals, but a falling off in the last months to unusually low levels. Business and engineering leaders in the field, however, express the opinion that an improvement in the situation in the first half of 1919 is probable.

In compiling the contracts from all sections of the country, it was found that approximately $4,100,000 worth of concrete contracts were let, $3,000,000 in steel contracts and approximately $3,600,000 worth of miscellaneous contracts. The average of the miscellaneous contracts was about $45,000 each, and that of the steel and concrete combined about $44,000; from which it was assumed that the miscellaneous contracts were about evenly divided between concrete and steel, the wood items being negligible. Dividing the miscellaneous contracts equally between the concrete and steel gives approximately $5,900,000 in concrete work and approximately $4,800,000 in steel work. These figures, however, owing to the present inflation of prices, will probably represent only about two-thirds the volume of business that an equal amount would show before the war, so that, in the case of steel work especially, the volume of business is so small as to be alarming to those making a study of the situation.

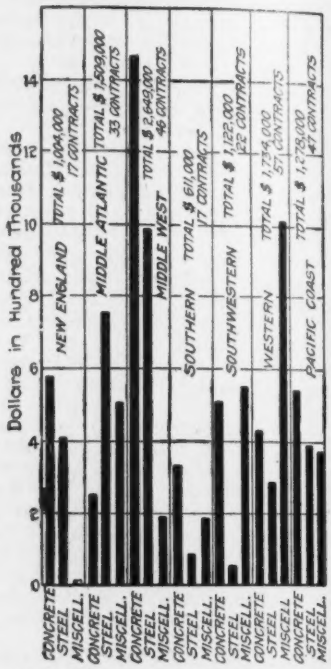


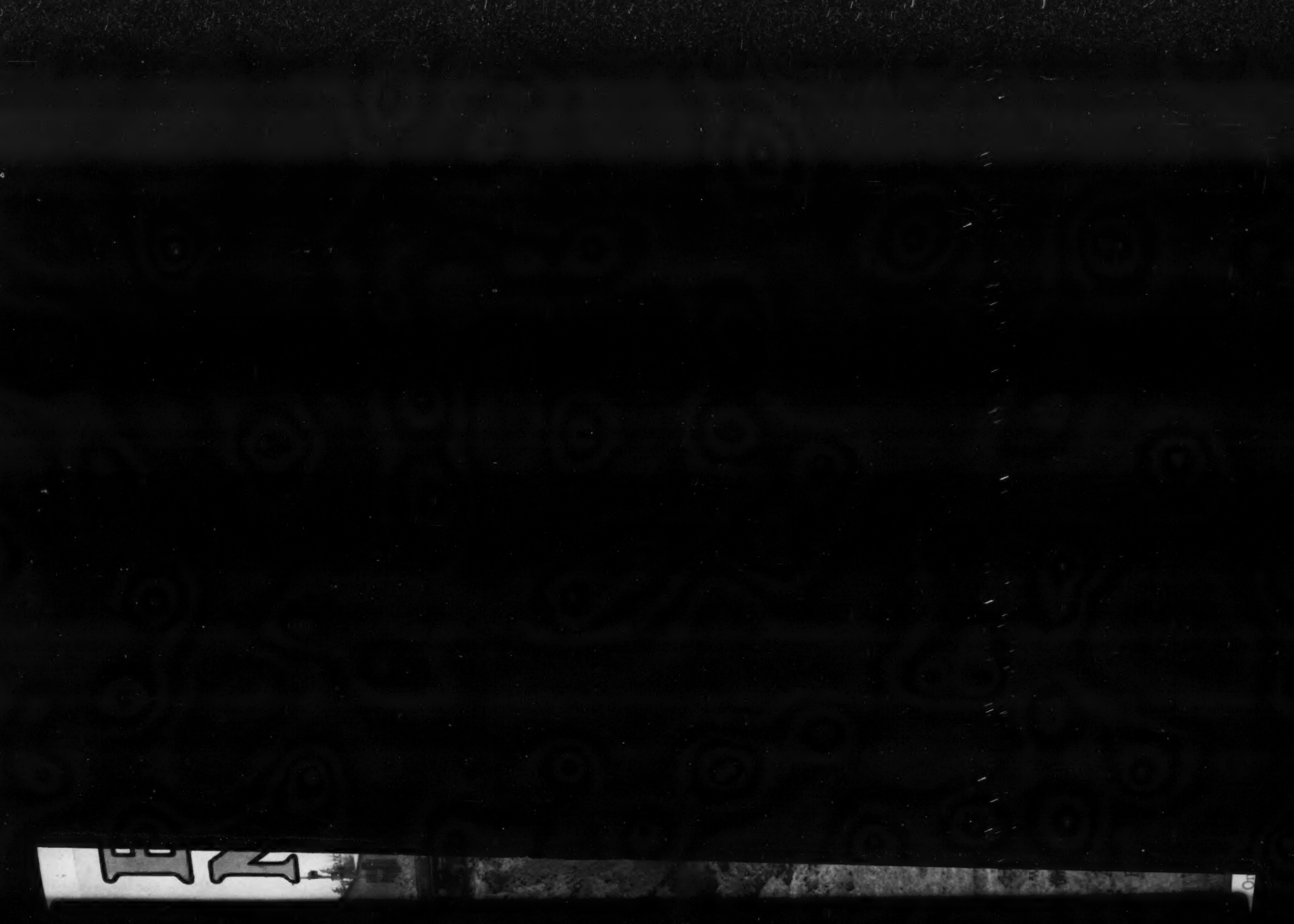
MONTHLY VOLUMES OF BRIDGE WORK

The tremendous war demand for steel, the price of labor and materials soaring to unprecedented levels, and the increasing demand on the railroads for all sorts of transportation, has placed unusually heavy burdens on the railroad bridge business. That the work must be done, however, is evident, since bridges occupy the position of the weak link in a chain in the transportation system.

The highway situation, owing to the availability of cement, sand and broken stone and the smaller sizes of steel reinforcing, is very much better, according to officials in this branch of the industry. A suggestion was recently made by some highway engineers in the cement industry that, since the various municipalities had the funds and these construction materials were available, two ends would be gained by carrying out the work at this time. It will enable the highways to take care of heavier tonnage than is now possible over hundreds of smaller bridges, and will save heavier repairs on the larger bridges later.

Highway officials state that owing to the relief of the railroads that is being effected by greater use of motor trucks in freight transportation, and the transporting of motor trucks themselves from the factories in the Middle West to the Atlantic seaboard, the main highway routes are becoming increasingly more important to the prosecution of the war. When the use of highways for motor trucks was proposed, at the beginning of the war, an investigation was made by the Office of Public Roads, regarding available routes. It was found that, owing to the heavy traffic, the highways, especially in the western parts of the Middle Atlantic States, were unable to take the traffic, making it necessary to make wide détours to reach the coast. It was found that in this case, also, the bridges formed the weakest links in the chain, that hundreds of them were unequal to the loads, and reconstruction is necessary. Although the Capital Issues Committee has supervision over expenditures down to $1000, much of this work can be done under this minimum.



NINE MONTHS' BRIDGE BUSINESS

DIVISIONS OF COUNTRY, FOR MAKING COMPARISONS